IS TODAY'S SCIENCE POLICY PREPARING US FOR THE FUTURE?

HEARING

BEFORE THE

COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

ONE HUNDRED FOURTH CONGRESS

FIRST SESSION

JANUARY 6, 1995

[No. 1]

Printed for the use of the Committee on Science

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IS TODAY'S SCIENCE POLICY PREPARING US FOR THE FUTURE?

FRIDAY, JANUARY 6, 1995

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE,
Washington, D.C.

The committee met, pursuant to call, at 9:30 a.m. in Room 2318, Rayburn House Office Building, Hon. Robert S. Walker [chairman of the committee] presiding.

The CHAIRMAN. The Science Committee's first hearing of the 104th Congress will come to order.

I am also very pleased to be presiding over this first hearing in the 104th Congress of the Committee on Science. As I said yesterday, I have served on this committee for 18 years, and it is truly a privilege for me to be sitting in this Chair and to have an opportunity to hear from the distinguished panel of witnesses that have come before us today.

There is a little story about President McKinley, who was advised by the Commissioner of Patents and Trademarks that the office should be abolished, since everything that could be invented had been invented. I often wish that we had agency heads that would display the Commissioner's enthusiasm for cutting government, but I also would not want that kind of lack of vision to be dominant in government. But I do hope that the Patent Office would be one that we would never have to abolish, because our society will have begun to die if we can find nothing more to invent and nothing more to improve our lives.

Americans have seen in the span of their lifetimes the Wright brothers fly, the arrival of the jet age, the moon landings, the invention of radio and television, digital technology and countless other advances in medicine, electronics and transportation. We should adopt as ours the goal of making the next century as exciting for the children born in the year 2001 as those who were born in the year of 1901.

In the recent past, it has become de rigueur for policymakers to chastise those in the private sector for focusing on the short-term bottom line at the expense of the longer term. In reality, those of us in the public sector have often been just as shortsighted, worrying about the current fiscal year without considering the effects of today's decisions on the future.

During this hearing, we will receive testimony from the heads of Federal departments and agencies over which this committee has jurisdiction.

It is my intention to focus on the long term, and I urge my colleagues to formulate their questions accordingly. We have asked our panel today to think about where today's policies are taking their respective departments and agencies into the future.

I should note that Secretary O'Leary was also invited, but had to decline because of personal business. She called me personally, would have liked to have been here, and we assured her that we will have her back in the future. That talk was a very good one, and she is prepared, I know, to discuss the long-term plans for the Energy Department.

[The prepared statements of Secretary O'Leary and Secretary Pena follow:]

Statement for the Record
by
Secretary of Energy Hazel R. O'Leary
to the
Committee on Science
United States House of Representatives

Impacts of Science and Technology: A Vision for the Year 2015

January 6, 1995

Mr. Chairman, Members of the Committee, I appreciate the invitation to testify at your first hearing of the 104th Congress and regret that a long-standing commitment prevents my personal attendance. As we agreed in our recent conversation, Mr. Chairman, I welcome the opportunity to appear before the Committee in the near future to present my views on the subject of this hearing, or on any other topic involving the Department of Energy.

You have presented a provocative and important challenge to your witnesses in asking each of us to discuss how our Departments are preparing to meet the revolutionary changes projected to occur in the next 20 years. During that period--as over the past 20 years--science and technology will yield powerful, yet in many cases unpredictable, new developments that will affect our economy, national security, environment, and quality of life.

As one of the nation's major supporters of federal research and development, the Department of Energy has a wide range of extremely exciting R&D programs under way that hold the potential to contribute in important ways to a better future. The basic framework for our investments is established through our statutory missions in energy resources and end-use technologies; national security, primarily as it relates to nuclear weapons-related science and

security issues; clean-up of the by products of nuclear weapons production; and fundamental science in areas that underlie these mission areas, including high-energy and nuclear physics.

Successful performance in each of these mission areas depends on further advances in scientific and technological research. For example:

- Achieving greater efficiency and diversity of energy sources will require new innovations in both energy production and utilization. By the year 2015, America's demand for electricity is expected to approach 4 trillion kilowatt-hours--up from 2.6 trillion kilowatt-hours in 1990. By this time, the fuel cell will likely have taken its place as an environmentally viable and cost-effective new option for generating some of this electricity demand--in no small part because of the joint public-private cost-shared R&D program which the Department has been supporting. The fuel cell will emit none of the smog-causing pollutants of conventional power sources, and will be ideal for distributed power sources--minimizing the need for long-distance transmission lines.

- Further reducing the nuclear danger will require major advances in our understanding of the fundamental science associated with nuclear weapons. In the year 2015, nuclear weapon stockpiles world-wide likely will have been reduced to but a small fraction of current levels (the Department currently is dismantling more than 2,000 nuclear weapons per year) and the safety and security

of nuclear weapons is expected to rest on an international regime in which nuclear weapons testing has been banned world-wide. Such accomplishments will depend on political developments, but also to a considerable degree on scientific and technical advances at the Department's National Laboratories which will ensure confidence in the safety and reliability of the U.S. nuclear arsenal in the absence of testing and in limiting the proliferation of nuclear materials and related technologies.

- The production of nuclear weapons over the past 50 years has generated a waste clean-up challenge that cannot affordably be addressed without major advances both in our understanding of the science of chemical and radioactive wastes and the development of new technologies for cleaning up contaminated sites. In the year 2015, innovative clean-up technologies could enable the Department to return up to 90 percent of today's 3,700 contaminated sites to other productive uses in society.

- By the year 2015, the private sector will have succeeded in taking fundamental new knowledge in molecular biology, materials science, and computational chemistry and turned them into commercial products. Some of this new knowledge will have emerged as a result of pioneering research performed at major user facilities operated at the Department's National Laboratories--where advanced "Light Sources" (which generate powerful beams of ultraviolet light and x-rays) are enabling academic, industrial, and

government researchers to explore scientific frontiers that cannot be reached in any other fashion.

Mr. Chairman, I could go on at considerable length in describing ongoing R&D programs of the Department of Energy that we believe will make substantial contributions in meeting the public missions of this agency. To a growing extent, these programs are being performed through partnerships including the Department and other government agencies, academia, and the private sector. One of the great challenges facing our nation is how best to integrate the complementary strengths and needs of R&D performers in the public and private sectors, with the goals of furthering U.S. leadership in science and technology, strengthening our economy and national security, and addressing national problems for which science and technology offer solutions. I look forward to the opportunity to testify before the Science Committee to describe in more detail our contributions toward meeting these goals.

STATEMENT FOR THE RECORD OF FEDERICO PEÑA
SECRETARY OF TRANSPORTATION

Before the Committee on Science, US House of Representatives

January 6, 1995

I welcome the opportunity to testify on the future impact of science and technology on transportation, and, in particular, on how the Department of Transportation is working to bring about important changes in transportation within a 20-year timeframe. This is a topic about which I have had strong feelings since becoming Secretary, and I have devoted considerable effort to assuring that the nation's transportation enterprise reaps the full benefits potentially available through wise applications of existing and emerging technologies. Technological development and deployment is one of the core goals in the Strategic Plan we developed last year for the Department. I will touch on several aspects of this topic: (1) our vision for the transportation system, (2) the major role I see for technology in realizing that vision, (3) steps we have taken to heighten the priority given research and technology within the Department, and (4) the nature and value of our work during the last year with the National Science and Technology Council (NSTC). I will conclude with some comments on space transportation, which I understand to be of special interest to this committee.

With respect to the broader issues raised by the Committee, the Department has given considerable thought as to how we can advance the Nation's transportation system. The long-term vision articulated in the DOT strategic plan is of a seamless intermodal transportation system that effectively ties America together and links it to the world. It will provide for safe, secure and efficient movement of goods and people throughout the nation while stimulating a strong and globally competitive economy, making sustainable use of natural resources and having minimal adverse societal and environmental impacts. But I stress that this is not simply a DOT vision. This vision represents the collective wisdom of many Federal agencies as coordinated by my Deputy Secretary in leading the activities of the NSTC Transportation Committee, which I address below. We see public- and private-sector technology investments as a necessity to assure continuing transportation improvements and continuing evolution to meet changing societal needs. Our sponsorship last fall of the "Transfuture" Technology Fair on the National Mall was a visible symbol of the Department's determination to encourage and accelerate the technological revolution in transportation. We are working closely with industry, National Labs, and other agencies and levels of government on solving problems and improving transportation

through development of safer vehicles, efficiency-enhancing intelligent transportation systems, and better intermodal connectivity.

Realization of this broad vision will be based on major advances in transportation technology. The Department is committed to playing a leading role in this process. The results, as identified in the NSTC Transportation Committees recent report, will include:

- A system of personal transportation that meets travel needs conveniently, and with a minimum of cost and delay. Government and industry will work to achieve the following goals within a decade:

  - *A production prototype of an affordable, attractive automobile capable of up to three times current fuel economy and meeting future standards for safety and air pollution.*

  - *A validated technology base which will enable the commercial development of a new generation of safe subsonic and high-speed civil transport aircraft that far surpass today's aircraft in affordability, efficiency, and environmental compatibility, as well as the development of a safer, more efficient and more productive air traffic management system*

  - *Demonstrated prototypes of bridges and highway surfaces capable of lasting years without pothole repairs or major maintenance.*

  - *Advanced, integrated highway, air, rail, and marine information systems that will monitor transport system performance and will provide operators and passengers the information they need to maximize flexibility and choice, and minimize congestion and environmental impact*

- A system of freight transportation that supports both traditional shipping needs and the new requirements of industries relying on fast, reliable, flexible deliveries. The government and industry will work to achieve the following goals within a decade:

  - *Prototypes of heavy trucks, rail locomotives, and buses that minimize the use of non-renewable resources, and will be safe, secure, economically viable, suitable for use by an increasingly diverse population, and, at the same time, be producible and create manufacturing jobs in the US based on both domestic and export markets.*

  - *A civilian space launch industry capable of competing in any unsubsidized international market.*

  - *Advanced technology ships and marine terminals that provide for the efficient flow of intermodal domestic and international commerce*

- A Federal procurement system based on life-cycle costing and performance specifications which gives private firms strong incentives to create and invest in innovations and to meet ambitious safety and environmental goals efficiently with a minimum of prescriptive regulation.

- A Federal government structure that supports wide and effective decisions, policies and legislation based on private sector input; comprehensive knowledge of the transportation system's condition, performance and operations; and understanding of the impacts and implications of alternative choices and courses of action.

In our work last year on the NSTC Transportation Committee the several working groups and subcommittees developed specific strategic goals judged to warrant high priority in transportation research and development investments, beyond funding necessary to continue to meet legislated agency mission responsibilities. The strategic goals are as follows:

- **Physical Infrastructure for Transportation:** Development of materials, design methods, non-destructive testing techniques, and other technologies for low-cost, long-lasting highways, bridges, airports, and other structures. Development of low-cost methods for non-destructive testing and repair of existing structures.

- **Information Infrastructure for Transportation:** Application of innovations available from the national information infrastructure to ensure efficient, safe operation of the Nation's air, highway, rail, and ship transportation systems.

- **Next-Generation Transportation Vehicles:**

  - **Aeronautics:** Maintenance of world leadership in aircraft, engines, avionics, and air transportation system equipment for a sustainable, global aviation system.

  - **Space Launch:** Assurance of reliable and affordable access to space through a stronger US space launch capability which meets the needs of the civilian, national security, and commercial sectors.

  - **Personal (Light-Duty) Motor Vehicles:** Renewed leadership in automotive technologies through the development of a new generation of energy efficient, low emission vehicles that will preserve American jobs and improve American competitiveness.

  - **Medium and Heavy Duty Motor Vehicles (Trucks and Buses):** Assurance of US leadership in truck and bus technology by investing in improved materials, components, and design

concepts and other technologies required for improved accessibility, energy efficiency and environmental characteristics.

- **Rail Vehicles (Intercity and Transit)**: Positioning of the US as a world technology leader and primary exporter of rail-related equipment and services by facilitating technological innovation in rail vehicle design and construction and by introducing advanced materials, and communications and control technologies which will result in improved performance and reduced costs.

- **Ships and Shipbuilding**: Improvement of the competitiveness of the US in ship building, ship repair, ship design, and ship production in order to ensure a strong US shipbuilding industry unsurpassed in building the finest and most complex vessels in the world, and competitive in world-wide markets.

- **Transportation System Design, Planning, Management and Operations**

  - **Transportation System Assessment Tools and Knowledge**: Development of information required for government and industry managers to make effective decisions about the operation of existing transportation systems as well as new investments.

  - **Human Performance in the Transportation System**: Definition of appropriate roles for the human in the loop through human center automation and improve the competitiveness of American products through the integration of human performance principles and procedures and the application of new information dissemination, communication, and display technologies to transportation.

I will now turn to specific current concerns and activities of the Department of Transportation. In keeping with the Department's fundamental responsibilities, the principal focus of our efforts to foster innovation must be safer and more efficient transportation. While our transportation system's transportation safety record is the envy of the world, the continuing high death toll on the Nation's highways and several recent aviation accidents remind us of the need for continued progress. I am particularly concerned that even with today's low fatality rates, projected growth rates for travel could result in as much as a doubling of total road and air fatalities over the next 20 years or so. I do not believe the American people will accept this prospect, and I certainly do not. But continuation of the rate of improvement achieved in recent decades will be a very challenging endeavor, and success will depend upon making the best possible use of new technologies in improving safety, and on coming to a better understanding of human performance and behavioral characteristics in interactions with transportation systems and operations. Research and development is a critical part of meeting our safety responsibilities.

In the closely-related area of transportation security, the FAA last month announced a major breakthrough with the certification of the world's first true explosive detection system. This joint effort by InVision Technologies and the FAA's Technical Center will result in a worldwide civil aviation system, within the next five to ten years, will be secure from terrorist attacks like the one the destroyed PanAm 103.

An efficient and effective transportation system is critical for US manufacturers if they are to compete effectively in the expanding global markets now being stimulated by trade agreements such as GATT and NAFTA. The Department's work has a significant impact on the overall performance and efficiency of the transportation system through its direct operational responsibilities for airways and waterways, the manner in which it exercises regulatory responsibilities, and its role in guiding and administering infrastructure investment to create a truly national system, while responding to local needs. Beyond these activities, DOT takes very seriously its role in advancing the technological base on which transportation rests. Through this means we improve transportation while also creating jobs by strengthening the competitiveness of US providers of transportation-related equipment and services.

Last May, my Director of Technology Deployment, Mr. Noah Rifkin, testified before this Committee's Subcommittee on Technology, Environment and Aviation. At that time he emphasized the efforts we are making to elevate the role of technology research and development in the Department, and to focus on the use and deployment of technology as a catalyst for organizational and cultural change at DOT. In addition to creating the post of Director of Technology Deployment as a key focal point, we have revitalized our existing internal structure of coordinating committees concerned with research and technology in a way that has significantly increased the priority given this important topic. We have also worked enthusiastically and diligently with the NSTC, established by the President to coordinate research among Federal agencies and chaired by Dr. John Gibbons. As requested by Dr. Gibbons, I took the lead in establishing one of nine NSTC committees, the Interagency Coordinating Committee on Transportation R&D. It is chaired by Deputy Secretary Downey, and has submitted several reports that provide important leadership in steering transportation-related R&D across the government and in guiding public and private-sector efforts to deal with critical transportation issues. Our work with other agencies in pursuing the NSTC activities -- primarily with NASA, the Environmental Protection Agency, and the Departments of Defense, Energy and Commerce -- has been especially satisfying. Although the effort is still very new, a great deal has been accomplished in the last year in clarifying the

mutual interests and potential synergies in many transportation-related R&D programs, and in setting coordinated priorities that will shape future budgets.

In a similar vein, the Department and the entire transportation enterprise will benefit greatly from our participation in the DOD Advanced Research Projects Agency (ARPA) Technology Reinvestment Project, which has resulted in substantial joint public-private investment in promising transportation-related applications of dual-use defense technologies. The consortia and partnerships created by this undertaking represent a particularly effective way of performing user-oriented R&D in application-oriented sectors such as transportation. In addition, we have detailed a DOT staff member to provide full coordination with the Department of Commerce Advanced Technology Program.

While the bulk of the Department's R&D is necessarily focused on specific and often shorter-term mission responsibilities, we have many programs across the transportation spectrum that are guiding and contributing to the major changes likely to occur over the next twenty years. Since the physical elements of transportation, such as highways, railroads, and vehicle fleets, can change only slowly, the most immediate and dramatic future improvements arise from innovations involving use of those assets more effectively and efficiently. Like many other spheres of activity, transportation is being dramatically affected by application of a wide range of information technologies -- such as sophisticated communications, satellite-based navigation, and computers -- in ways have direct impacts on performance, service levels, capacity, safety and efficiency throughout the transportation system.

The term Intelligent Transportation Systems (ITS), formerly called "Intelligent Vehicle-Highway Systems," is now being widely used as shorthand for the many ways in which these technologies support better use of existing and new transportation infrastructure. This is a very exciting area, and I will address it in some detail. Examples include reduced congestion through better traffic management on urban highways, smooth flow of commercial vehicles across state and national borders, and availability of detailed and accurate information to shippers and travelers as a basis for decisions, particularly by making use of the National Information Infrastructure. The lead for ground applications of this activity in the Department is with the Federal Highway Administration (FHWA), but all modes are increasingly active in this area. We have established an ITS Joint Program Office to provide the vision, leadership and strategic guidance necessary to realize the promise of ITS deployment across all modes. This office is facilitating the coordinated development and deployment of advanced

technologies, consistent with the first objective in the DOT's strategic goal of creating a new alliance between the transportation and technology industries.

The Department's ITS Program fulfills the governmental role of providing seed money to facilitate the deployment of infrastructure needed to sustain private sector developmental and marketing efforts for technologies and services that are arising from the joining of the transportation and information technology industries, and to foster public/private partnerships to accelerate the development of this emerging industry and increase US competitiveness. The ITS initiative provides intermodal travel information to individuals; facilitates the efficient movement of goods through the commercial vehicle industry; allows for the efficient operation of the nation's surface transportation infrastructure; creates a safer and more secure environment for travelers; and fosters development of an emerging industry which combines transportation and information technology.

The Traveler Information Systems subset of ITS includes the vision of a complete range of intermodal transportation information before a trip begins, and of travel advisories and route guidance once a trip is underway. An example of an early version is the recently completed Smart Traveler operational test in Boston involving a public/private partnership. Also, General Motors recently announced that it will begin test marketing in California an on-board navigation device using GPS satellites and other techniques to determine vehicle location. And Avis is offering navigation devices in its rental cars in California and Florida.

Advanced Transportation Management Systems will integrate the control and operation of surface streets and freeways, as well as a transit and emergency vehicle fleet management system, allowing these systems to respond in real-time to changing traffic conditions. Westinghouse, for example, has been active in the development of automated vehicle location computer-aided dispatch systems, particularly for the transit industry.

Commercial vehicles are being equipped with technologies which provide real-time traffic and vehicle location information, allowing optimal fleet management, and reliable delivery scheduling, as well on-board safety monitoring equipment. HELP, Inc. is the outgrowth of a successful FHWA operational test. It is a partnership between the States along the I-5 west coast corridor and the motor carrier industry to provide electronic clearance for properly equipped and documented trucks. Individual vehicles are being redesigned to implement collision avoidance technologies which sense and provide warnings for potential or imminent collision situations. The entire

Greyhound bus fleet is being equipped with a blind spot detection and collision avoidance system called VORAD developed by Eaton.

But the revolutionary application of information technologies to transportation affects not only highways, but all modes of transportation. A major portion of Federal Aviation Administration R&D has, of course, always been in the area of air traffic control and management. The aviation system of the future will build on these technologies -- particularly on the new capabilities offered by satellite-based positioning and navigation systems -- to permit evolution toward a more seamless system of "free flight" that will increase capacity and efficiency of the National Airspace System. The Federal Railroad Administration (FRA) is actively working with the industry on systems for central control of trains to maintain safe separation from each other and safe passage through highway-rail grade crossings, and on management of railroad operations by using locomotive-mounted GPS receivers and Geographic Information Systems. The Research and Special Programs Administration (RSPA) has responsibility for coordinating the Department's participation in the National Information Infrastructure Initiative.

While exploiting the opportunities offered by these technologies is largely the work of the private sector, the Federal government has several clear and important roles to play, working in partnership with industry and academia. The first, as I noted above, is that of a catalyst and source of seed money and technical assistance from Federal laboratories and other sources of relevant special expertise. A related responsibility is the fostering of university research, particularly at University Research Centers, under the RSPA university research grants program. A second key role, in which I see the Department of Transportation as necessarily taking a lead role, is that of assisting in the establishment of consensus on national and even international standards for the use of new technologies and applications. Only with such standards can these technologies grow to form both a cohesive national system and a true mass market, both domestically and abroad. Finally, the government has a broad responsibility not only to ensure the safety of any new technologies used in transportation, in itself an increasingly challenging task, but also to identify and stimulate innovations that serve primarily to improve safety, such as vehicle collision avoidance.

The vehicles and physical infrastructure that make transportation possible are also central to long-term advances. Each of the Department's operating administrations is highly sensitive to opportunities to work with the private sector to contribute to innovation in areas consistent with agency missions. Thus, we find the Federal Transit Administration involved with the industry on alternative-fuel and electric buses, the

Maritime Administration participating actively with ARPA in the MARITECH initiative to improve shipbuilding, and the Federal Railroad Administration exploring ways to contribute to the development of alternative fuel and high-speed non-electric locomotives. The National Highway Traffic Safety Administration's core focus on automobile crashworthiness is a natural element of the public-private Partnership for a New Generation of Vehicles (PNGV) being led by DOC. RSPA has taken the lead in coordinating our extensive participation in the ARPA-led Technology Reinvestment Program, which has included participation in the evaluation process and monitoring of several transportation-related awards. This activity assures the maximum mutual benefits for both defense and civil applications in areas of common interest. The cost-shared TRP has stimulated substantial private-sector investment directed toward transportation. In short, we are devoting a very large effort to coordination of transportation research and technology activities both within the Department and across the Federal government.

On the basis of the Transportation Committee's work, the NSTC identified R&D related to the physical infrastructure of transportation -- primarily concerning application of new and high-performance materials and structures to transportation construction, and use of advanced non-destructive techniques for monitoring and inspection -- as one of eight priority areas. These topics represent major thrusts for Federal Highway Administration R&D, and the Federal Aviation Administration program addresses improvements in construction and monitoring of runway pavements needed for the much heavier aircraft anticipated early in the next century. FRA continues to work actively on techniques for better inspection of rail vehicles, components and track.

However, improved technologies are only part of the story. Transportation decisions, whether made in the public or private sector, must address a steadily widening range of considerations, including environmental and safety impacts; economic effects for various segments of the population; national energy and petroleum consumption; land use and living patterns; international agreements; global competitiveness and balance of payments; and appropriate roles of each involved party. We must improve our ability to make wise and balanced cross-modal and multi-modal R&D and infrastructure investment and resource allocation decisions. National goals embodied in Federal legislation place heavy burdens on state and local agencies for planning and decision-making in areas of technical complexity. We are developing information and tools for use in meeting these challenges to remedy situations in which they are difficult to obtain or simply do not exist. Estimation of the consequences of alternative courses of action are shrouded in uncertainty.

Issues of this type include the appropriate role of high speed passenger rail systems in the US, development of acceptable strategies for dealing with air quality mandates and urban congestion, and the clash between environmental concerns and the need for transportation infrastructure renewal and expansion. The models and data available to address these issues often provide an inadequate foundation for satisfactory resolution. Further, the models often so complex or data-intensive that their use by local authorities, who have primary responsibility for many issues, is problematic. Gaps in our understanding of the workings of the national transportation system plague not only governmental agencies and businesses, but also legislative bodies trying to legislate and appropriate productively. Such gaps make it difficult to assure the value and cost-effectiveness of proposed regulatory actions. In other cases, uncertainty as to the market viability of truly innovative products can diminish or preclude private R&D even in areas of real technical promise. Better understanding and models can be very helpful in resolving such issues.

Accordingly, the NSTC Transportation Committee concluded that there is an acute need for improved data, analyses and assessments of all aspects of transportation system performance, including environmental impacts and behavioral factors affecting travel choices, to support policy development and implementation, regulations, legislation and planning by governments at all levels and the private sector. The Department is fully supportive of this goal, and is currently working with appropriate agencies to coordinate a responsive long-term comprehensive activity. Ongoing activities of this nature include work on performance indicators by the new Bureau of Transportation Statistics, FHWA transportation system modeling and environmental studies, FRA's study of the commercial feasibility of high speed ground transportation systems, and FAA's annual projection of future air traffic. In FY 1996 we will have a major involvement in assessing the impacts of alternative technological realizations of a personal motor vehicle with three times the fuel efficiency of current cars, as envisioned by the PNGV.

In view of this committee's special interest in space, I will add some comments on our role in that area. We believe that the US commercial space transportation industry, in partnership with Federal and state governments, has the potential to create jobs, strengthen the economy, and lead the way to a productive new industry sector. DOT's Office of Commercial Space Transportation has been an active participant in developing an implementation plan for the President's National Space Transportation Policy which was announced last August. This plan is designed to ensure low-cost access to space and the international competitiveness of the US space transportation industry, which also serves our military, intelligence, and civil launch needs.

During 1995, DOT will be updating launch regulations, assisting in negotiation of international agreements to promote stability in the launch market, and developing an inventory of facility needs of the US commercial space transportation industry. Within the basic constraint of maintaining safety, we are looking carefully at ways to minimize regulatory burdens and encourage innovation and entreprenuership.

Just a few weeks ago we announced plans for a major restructuring of the Department of Transportation -- the first since DOT was created 27 years ago. It will include corporatization of the air traffic control functions of the FAA and substantial consolidation of our 10 separate operating administrations, in addition to streamlining the way we do business and a significant downsizing. While we have not yet completed the process of determining the most effective structure for the Department, I can assure you that we are giving special attention to how best to integrate research and technology activities with our many and varied mission responsibilities, and to position the Department to continue to serve as a technology steward and stimulus for the entire transportation enterprise.

Mr. Chairman, I look forward to working with you and the Members of the Committee in this important area.

The CHAIRMAN. I thank each member of the panel for appearing here this morning and I am looking forward to their testimony. I understand that the former Chairman of the committee, Mr. Brown, is at another meeting now. I will defer his opening statement until he gets here. When he gets here, we will let him testify.

I would like to welcome the other Members of the Science Committee here this morning and move directly—is there anyone else here among the Members of the committee that would have a very brief opening statement? I would like to limit them so that we can get right to our panel.

I think we are going to go right to the panel.

The first witness this morning for the panel will be the Honorable Ron Brown, Secretary of the Department of Commerce.

STATEMENT OF THE HONORABLE RONALD H. BROWN, SECRETARY, UNITED STATES DEPARTMENT OF COMMERCE

Secretary BROWN. Thank you very much, Mr. Chairman. It is an honor and a pleasure to be here, a special honor to be here at the first hearing of this committee and to be the first witness before your committee.

Let me begin, if I might, Mr. Chairman, by commending you for holding this hearing, and even more importantly, for asking just the right and just the appropriate question: How can our efforts today lay the groundwork for a strong and vibrant economy in the year 2015 and beyond?

Our vision of the year 2015 is of a United States economy which is sustained by growth and by the creation of economic opportunity for all of the American people, a place where dynamic American businesses and highly skilled American workers use advanced technologies to produce the goods and services that consumers will demand both here at home and all around the world. To reach that vision requires that we employ each ingredient of our national economic growth strategy—investment, a skilled work force, open markets and, of course, innovation.

It is the private sector that drives competition and growth. It is critical, we believe, to support private investment through sustained progress on cutting the Federal deficit. That is why President Clinton fought so hard and so successfully for deficit reduction that got government out of business's way, at least in our capital markets. The result: Since the end of 1992 business investment in plant and equipment has increased at an annual rate of 14 percent.

For firms to succeed it is also necessary that we have educated and well-trained workers. To continue to be the most competitive nation in the world, we need the best work force in the world, and that is why the President's middle class tax cut is focused on education and training.

Opening markets for United States businesses has been a priority of this administration. The passage of the North American Free Trade Agreement and the Uruguay Round GATT agreement will create enormous potential for world trade and for economic growth.

The administration of national export strategy is helping American companies—small, medium and large—to realize their full potential. Each of these three ingredients is integrally linked to the fourth, the fourth being innovation.

In each of these areas, the administration has taken action that is focused directly on the importance of innovation, ranging from extension of the R&E tax credit and a targeted capital gains reduction for investment in small businesses to boosting educational opportunities for our young people, to freeing $32 billion in exports by reducing unnecessary controls on United States computer and telecommunications and electronics products. Through all of these efforts, innovation is being spurred.

The close connection between innovation and economic performance has been reconfirmed by new research from my own department's economic statistics administration which was released last month. That report announced that firms using advanced technologies are more productive, that they pay higher wages, they offer more secure jobs and that they increase employment more rapidly than firms which do not.

The chart on the left, which has a crowd of people around it, illustrates, we believe, the vital role that industry-government partnership and leveraging activities play in the progress of science and technology. Of the $84 billion that American industry spends annually, 90 percent is focused on short-term product development and applied research. In today's fiercely competitive and global marketplace, in which product life cycles are measured in months, industry's focus must in fact be on short-term product and process innovations.

On the other hand, the United States Government makes longer-term investments in basic science and mission-oriented research and development. That is where the $70 billion spent by our government chiefly goes, including funding my own department's NIST laboratories and NOAA basic research.

As the next chart shows, 58 percent of the Federal government's research and development funding relates to the mission of defense and most of the rest of the basic and mission-oriented research. But that still leaves a major gap. As the first chart showed, industry-government partnership and leverage activities are less than 2 percent of government-funded R&D. Like any portfolio, we believe the mix of R&D activities must reflect a balance between long-term and short-term goals. While research and applied science is a vital component of our innovation portfolio and while short-term commercialization is necessary and in fact essential, it is not enough. We have learned over the past 20 years that too often United States discoveries of basic knowledge were better exploited by other countries that were better able to develop applicable technologies and transform them into competitive products and services. The marketplace alone will not invest sufficient resources into the mid- and longer-term, broad-based technology development needed by the private sector to fully exploit the basic knowledge which we develop.

Our industry-led technology development partnerships are an important link between basic science and private sector commercialization. These funds are highly leveraged by industry investment and promise widespread economic benefit to our Nation. This critical fraction of a percent helps build the industrial base we need to support our national and our economic security. We believe that

it must be supported. To do otherwise would be tantamount to unilateral disarmament in the global marketplace.

Consider the research and development expenditures of our major trading partners, which are illustrated on chart number 3. As a percentage of GDP, we lag behind Japan and Germany and are roughly on a par with France and the United Kingdom. Our ATP program helps address the shortfall.

By sharing the costs of research, the ATP program reduces the risk for private businesses, thus allowing them to conduct R&D that might otherwise not be conducted at all. Through a rigorous merit-based review, the ATP program ensures that funded research has both technological and commercial potential, and with a bottom-up private-sector approach, the ATP program maintains private sector priorities, not government fiat. It maintains them as the driving force for technological achievement and for focus.

The first four years of the ATP program have shown small business in particular to be eager participants. As the next chart shows, Mr. Chairman, the awards made since 1990—of the awards made since 1990 roughly half have been to individual small businesses or joint ventures led by small businesses.

Diamond Semiconductor Group of Gloucester, Massachusetts, is a perfect effect example of this emphasis. This company was a two-person operation with a promising but unrealized innovation in semiconductor manufacturing. It helped to develop a new type of ion implantation machine, one of the primary tools of the industry. The new machine would be smaller, faster, cheaper and more accurate but required design breakthroughs that are considered very difficult and very expensive.

The goal is replace current semiconductor wafers with a 12-inch semiconductor wafer that would permit greater economies of scale and therefore more efficient production of semiconductors, the type of wafer that I hold in my hands. The concept wasn't easy to sell; Diamond's President spent a year and a half looking for funding.

I know there is a theory that venture capitalists will fund anything. They won't fund anything. They want something they can feel and touch and that they know will move quickly to commercialization. Those efforts to deal with the venture capital community proved unsuccessful, and the President of Diamond even considered selling part of his company to foreign investors to raise the capital.

Fortunately, the company decided to first apply for an ATP award. Their project was one of 21 selected in 1992. Today, with contracts and purchase orders from two of the Nation's largest semiconductor manufacturers in hand Diamond has grown to 35 full- and part-time employees. Its American owners credit the company's success, in fact the company's very existence, to the ATP award for a high-risk technology that only became attractive to a private-sector investor once it was shown to be feasible.

Stimulating the development of innovative technologies is only half of the equation. The other half, getting new and existing products to market on a timely, cost-effective, competitive basis is also critical. America's 370,000 small- and medium-size manufacturers will have easy access to modern manufacturing technologies and production techniques and best practices through the manufactur-

ing extension partnership, our national system, which is illustrated in the next chart.

The MEP centers are industry driven. They are responsive and they are focused on positive bottom line impacts. Mr. Chairman, you can see from the spread across the Nation that we are serious about reaching out to small- and medium-size businesses to help make them more productive and more competitive, to put new technology—not only high technology, but all new technology—in the hands of these entrepreneurs so they can help us create economic growth and jobs.

[The information follows:]

CHART 1

Enabling the Nation's Capacity to Perform in a Global Community

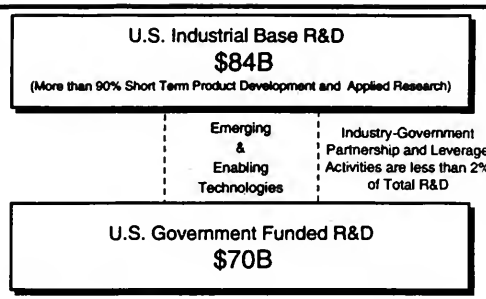


CHART 2

Federal R&D Funding for Defense & Civilian Functions, 1993

Source: NSF "Federal R&D Funding by Budget Function: FY 1991-93" and unpublished NSF data.

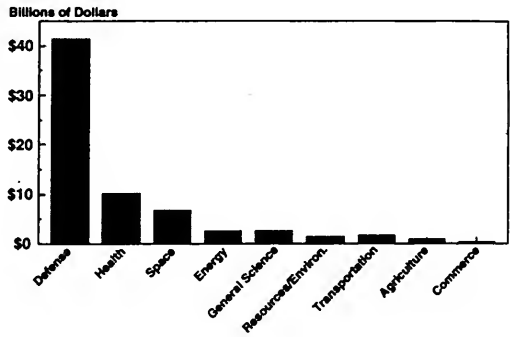


CHART 3

National Nondefense R&D as a Percentage of GDP, by Country, 1981, 1986, 1991

Source: NSF S&E Indicators-1993

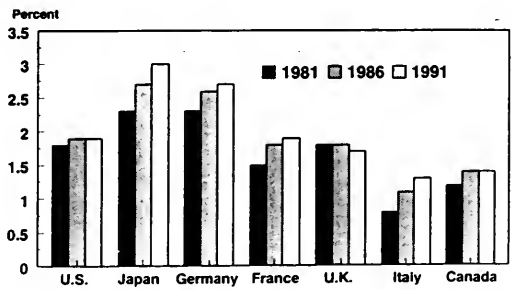
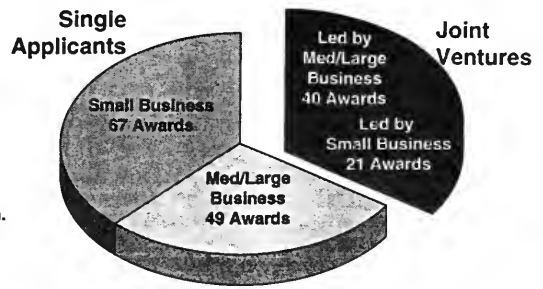


CHART 4

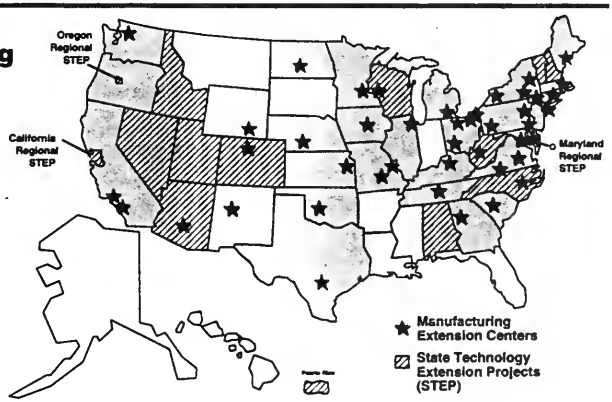
ATP Awards 1990-1994 By Type of Organization



Awardees include 158 small businesses, 221 med/large businesses, and 32 universities. 100 subcontracts have also gone to universities.

CHART 5

NIST Manufacturing Extension Partnership



Secretary BROWN. Mr. Chairman and Members of the committee, if my testimony this morning has attempted anything, it is this: We live in an increasingly competitive global economy in which all aspects of economic competitiveness are integrally connected. The Department of Commerce is where these connections are made. Some have suggested, some very smart people have suggested that we need to create a new department of the future.

I respectfully submit, Mr. Chairman, that what we need, what America's businesses need, what America's communities need, what America's workers need is a department focused on export growth, a department focused on technological innovation, focused on sustainable development, focused economic development and focused on sound economic analysis. The department of the future, in other words, I believe is today's Department of Commerce. Within our 10 bureaus we work better in every respect because we are every day confronted with the intersection of trade and technology and telecommunications and the environment and economic development. That intersection is where the future of the United States economy is being fashioned every day by entrepreneurs who forge our future—one deal, one contract, one joint venture, one transaction at a time.

This administration, through the Department of Commerce and all of us here at the witness table today, along with our colleagues, works every day with these entrepreneurs to our mutual and, we believe, our future benefit.

Thank you very much, Mr. Chairman.

[The prepared statement of Secretary Brown follows:]

TESTIMONY OF

SECRETARY RON BROWN

ON

SCIENCE AND TECHNOLOGY --

PREPARING FOR CHANGES IN THE YEAR 2015

BEFORE THE

COMMITTEE ON SCIENCE

HOUSE OF REPRESENTATIVES

JANUARY 6, 1995

Mr. Chairman, Mr. Brown and members of the Committee.

Let me begin, Mr. Chairman, by commending you for holding this hearing and, even more importantly, for asking exactly the right question: How can our efforts today lay the groundwork for a strong and vibrant economy twenty years hence?

Today, we are harvesting the results of research and technology investments made ten, twenty and thirty years ago. These are stories of remarkable success, due to the foresight of our predecessors who recognized that support of research and development and technology deployment is a fundamental mechanism for achieving national missions and a stronger economy.

Our vision twenty years from now is one of a United States economy sustained by growth, creating economic opportunities for all Americans. A place where U.S. businesses use globally competitive advanced processes to produce the goods and services that world consumers will demand – success stories of the 21st Century built on the farsighted actions of today and tomorrow.

We now have the opportunity to begin these stories. But to do so requires that we understand the nature of our economy and the lessons of our past support for science and technology efforts.

I. New Economic Realities

Mr. Chairman, we are facing a time of great economic change. We have witnessed the demise of communism as freedom and democracy fill new nations with hope and opportunity. I have visited these economies in transition – South Africa, the Middle East, Russia – places where a new economic future is being built.

At the same time, a new battlefield has emerged in the form of a global marketplace, and able competitors from around the world are fighting for a share. Technology is racing ahead at a breath-taking pace, with each advance more staggering than the last.

And, in the wake of these forces, the way we live, learn, work, and play is being forever transformed. Each of these changes alone would be revolutionary but, together, they have produced results that are deeply felt by Americans in all walks of life.

These changes create uncertainties -- and opportunities. We must confront the basic challenge of our time: Will we try to hold change at arms-length or will we take advantage of the opportunities that change will bring? And we must answer that challenge with this strategy: to empower Americans with the tools that they need to take advantage of economic opportunity.

We must work as a nation -- with our businesses, with our workers, with our communities -- to ensure that the United States remains the locus of dynamic firms, strong communities and skilled workers. In today's economy, it is not just companies, it is also nations that compete.

Consider the ingredients of sustainable national economic growth: investment, a skilled workforce, open markets and innovation. Together, they form the basic equation of international competitiveness.

Today's hearing focuses on preparing for a vibrant economy twenty years from now. My principal emphasis will be on innovation, which I will discuss in detail. It is important, however, that we bear in mind our responsibility to further the national interest in each of the four ingredients.

First, investment. Private investment drives competition and growth. It is critical to support private investment through sustained progress on budget deficits. That is why President Clinton fought so hard -- and so successfully -- for a deficit reduction package that got government out of businesses' way in our capital markets. The result: since the end of 1992, business investment in plant and equipment has increased at an annual rate of 14%.

Private investment provides a lifeline for those dynamic firms that spur technological innovation, create jobs and foster economic growth. For example, two-thirds of the manufacturing jobs created each year originate in plants that grow by 25 percent or more in that year alone. The basic lesson is clear: Our economy is only as strong as the best firms that populate it.

Second, a skilled workforce. For firms to succeed in the economy, however, it is necessary that we have an educated, well-trained workforce. Traditional economists might view knowledge and labor as two distinct sources of economic growth but, in today's information-based economy, the prowess of our workforce is increasingly bound to the success of education and training. We cannot capitalize on advances in science and technology without a workforce able to harness these innovations. That is why the President's middle class tax cut is focused on education and training.

Third, open markets – both foreign and domestic. As you know, Mr. Chairman, opening foreign markets to the effective participation of U.S. businesses has been a priority of this Administration, of the Department of Commerce and of my own activities. Of course, our leadership in science and technology will only bear fruit if we have markets open to our innovative products.

The passage of the North American Free Trade Agreement (NAFTA) and of the Uruguay Round GATT agreement will create enormous potential for world trade and economic growth. NAFTA has begun to take economic hold. U.S. exports to Mexico shot up 23 percent in the first 10 months of 1994 compared to the same period a year earlier. Mexico and Canada alone accounted for nearly half the growth of global U.S. exports during this period. When fully implemented, GATT should add as much as $100 billion to $200 billion to the U.S. gross domestic product annually; raise total U.S. employment by hundreds of thousands of jobs; save individual U.S. consumers hundreds of dollars annually in lower costs of food and other important items; and boost real wages and living standards in the U.S. and around the world.

The framework of open markets is, however, not enough. Exploiting those opportunities is just as critical. That is why the inter-agency Trade Promotion Coordinating Committee, which I chair, issued the first National Export Strategy in 1993 and refined that strategy in a report issued last

September. The purpose of the National Export Strategy is clear: to help U.S. companies -- small, medium and large -- realize their full export potential.

Boosting U.S. exports is a core mission of the Department of Commerce. Our advocacy, and that of President Clinton, on behalf of U.S. businesses competing for foreign government procurements is beginning to bear fruit:

- in Saudi Arabia's intent to purchase aircraft from the Boeing Co. and McDonnell Douglas Corp., valued at $6 billion, and that country's $4 billion contract for telecommunications network modernization awarded to AT&T;

- in Brazil's award of the $1.5 billion SIVAM rain-forest protection contract to the Raytheon Company, a defense contractor moving into civilian production; and

- in China's agreement to purchase $6 billion worth of goods and services from U.S. companies, including two Westinghouse contracts worth $450 million, an Applied Energy Services contract worth $1.5 billion, and an AT&T agreement valued at $500 million to provide telecommunications equipment.

Of course, markets here at home must be dynamic and competitive as well. We live in a global era in which success at home will often translate into success abroad but in which, conversely, failure to achieve success at home will leave domestic firms at risk in the United States and at a competitive disadvantage abroad. That is why, for example, the Administration has placed such emphasis on the passage of telecommunications legislation that will deregulate and open new markets. We look forward to working with the 104th Congress to reform our 60-year old communications law to remove legal and regulatory impediments to competition while still safeguarding the public interest.

The importance of this effort is too obvious to ignore. Last year the Council of Economic Advisors issued a report detailing the economic benefits that would be derived from telecommunications reform. The CEA predicts a boom in the telecommunications and information sector of the economy over the next ten years, doubling its share of the GDP, adding more than $100

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billion to the economy, and employing another 1.4 million workers in that sector.

Fourth, innovation. Technological innovation is vital in the new knowledge-based global economy. Rapid and continuous improvements in products, and the techniques to manufacture and bring them to market more efficiently, give businesses -- and nations -- a competitive edge today and twenty years from now.

In this environment, it is easy to see why the high-technology sector and firms that adopt advanced technologies are critical to economic prosperity. Average annual compensation in the high technology sector, for example, exceeds by twenty percent the average for all manufacturing. High-technology products also account for a rapidly increasing share of the manufacturing output of industrial countries -- 35 percent in 1992, nearly double the 1980 figure.

The close connection between innovation and economic performance has been confirmed by new research from my own Department released only last month. Our report, entitled "Technology, Economic Growth and Employment," found that firms that use advanced technologies are more productive, pay higher wages, offer more secure jobs, and increase employment more rapidly than firms that do not.

The importance of this conclusion cannot be overstated. It is central to our economic fate. That is why my Department has focused its attention on this central question: How can we stimulate innovation in the U.S. economy?

Part of the answer comes from the connection between and among the four basic ingredients of growth that I have outlined. Each of the other three ingredients -- investment, a skilled workforce and open markets -- is integrally linked to the fourth, innovation. A sound macroeconomic environment, educated workers and markets in which innovation can produce competitive success are all necessary to the successful promotion of innovation.

Indeed, in each of the these areas, the Administration has taken action that is focused directly on the importance of innovation, including:

- winning Congressional approval for a three-year extension of the R&E tax credit and a targeted capital gains reduction for investments in small business;

- working with Congress to create the School-to-Work transition program for young people who choose not to go directly to college, and establishing Goals 2000 standards for K through 12 education;

- improving access to college loans so that our future scientists and engineers can get the education they need;

- freeing $32 billion in exports by reducing controls on U.S. computer and telecommunications products;

- stimulating major sales of technology-based products for U.S. companies through high-profile industry-government trade missions that helped close contracts worth more than $17 billion in U.S. exports, involving 275,000 American jobs -- many of them technology related;

- developing a new Presidential policy on commercial remote sensing that allows private firms to build and operate high-resolution satellite imaging systems, which will create manufacturing and operation jobs;

- negotiating commercial space launch trade agreements with the governments of Russia and China to create a level playing field on which U.S. providers can compete;

- application of new technologies, from satellites to doppler radars, for better weather warnings and the protection of life and property.

And, what it has also done, is to provide adequate funding for basic science and applied research -- even within the hard freeze on discretionary spending that the President has proposed continuing through Fiscal Year 2000.

We should recognize at the outset that the Contract with America would jeopardize that technology policy. Among the possible offsets proposed by the

Contract are the elimination of our Advanced Technology Program and a freeze on funding for our National Oceanic and Atmospheric Administration, which conducts much of the Department's basic research. Moreover, generalized reductions in the President's investment spending, totalling more than $1 billion over five years, would further threaten our research and technology initiatives. For reasons that I will explain in detail, I hope that the Congress, after full consideration of our efforts, will continue the pro-science, pro-technology path that the President has forged and that is essential to our long-term economic prosperity.

Through all of these efforts, innovation can be spurred. But, for reasons that I will explain below, these measures alone are not sufficient.

II. The Need for Pro-Innovation Policies

The United States has been a leader in innovation. From the electric telegraph, to the telephone, television, personal computer and the manned mission to the moon, this nation has always looked to the future -- and invented ways of getting there sooner.

The United States must remain the world's leader in innovation. To do that requires an understanding of the incentives that create -- and the barriers that can stop -- both the development and deployment of technology.

Technological innovation is a complex process. It is so complex that each industry -- and even each firm within an industry -- must grapple with a different set of concerns. For example, strengthening intellectual property protection is a key concern, particularly for the software industry. Cold war era export controls have hurt the US computer and telecommunications industries. Regulation can be a major impediment by increasing the time and capital it takes to bring a new product to market -- especially in biotechnology and pharmaceuticals. Both capital availability and access to technical expertise are continuing struggles, especially for our small- and medium-sized companies.

In short, there is no "one size fits all" formula for ensuring that our companies lead the world in innovation. Our national competitiveness strategy must address the broad range of factors that affect our companies' ability to

develop technology, turn innovations into products and services and bring them to global markets at a rapid pace.

While innovation must continue to come from the private sector, government must work to maximize opportunities for private businesses to innovate – by reducing export controls, reforming regulations to give our companies and our workers elbow room to compete, by opening markets, by improving education, and by creating incentives for private industry to invest in long-range, high-risk research.

My department is pursuing a broad range of initiatives to improve the climate for private sector innovation. We are listening to industry as we establish departmental priorities, and serving as industry's advocate in shaping regulatory, export control and environmental policies. And we are partnering with industry to work on the nation's 21st century technological infrastructure.

This partnership continues a long history of cooperation between the public and private sectors. For the greater part of two centuries, the government has worked as a junior partner with industry to build or encourage American infrastructure. That infrastructure has created a "playing field" upon which private enterprise built the most successful economy in the world. Government has built lighthouses and harbors for private sector shipping, offered federal rights-of-way for private sector railroads, built interstate highways, airports, advanced radar for aircraft, next generation doppler radar, and GOES satellites. By making investments that individual entrepreneurs, or even large companies, could not afford to make themselves, the government enabled everyone to become more efficient and productive.

And the government's investments in infrastructure have not been limited to our physical infrastructure. Since World War II, our national government has invested in science and technology as part of key national missions--defense of the nation, health, space, and the quest for new knowledge. And, for years, we have seen a steady flow of new commercial technologies emerge from these government investments as an extra benefit.

As a result of government's technology investments, the U.S. computer industry is the world's leader. We have seen a flow of blockbuster drugs and medical therapies, and the birth of the biotechnology industry--all of which can

be traced to earlier government investments in defense technology or medical research. NASA's aeronautics research program provides America's aircraft industry with the mid- and long-term technology development that a single company, no matter how large, could not afford to do on its own.

Development of technology is not enough. We must also consider the extent it actually reaches those who can employ it effectively. That is why, as a nation, we have supported the deployment of technology to people who might not have the resources to find it on their own. For example, beginning this January, the Department's National Meteorological Center will issue experimental seasonal climate forecasts for the contiguous United States and Alaska. These forecasts will lead to substantial immediate benefits to the U.S., including the agriculture and water resources management sectors, and other sectors dependent on seasonal variability.

The development and deployment of technology are both part of today's great national mission of providing all Americans with the tools of economic opportunity.

First, we must focus on the national interest. In the past, federal action was focused on specific missions: defense, aeronautics, energy or health. But today, our focus must be broader, because we do not have the luxury of three separate industrial bases for military, mission-oriented and commercial purposes. Today, instead of looking for spin-offs down the road from some non-commercial purpose, we must examine the pursuit of civilian technology as a mission in and of itself, but we must do that only as a partner with industry.

Second, in examining that goal, we must recognize that all research and development and technology deployment is not the same. In this regard, we might usefully consider the nation's R&D expenditures as building a portfolio for the future.

In 1993, industry funded nearly 55% of all U.S. R&D. More than 90% of that industrial research was concentrated on short-term commercial development and applied reach. And properly so, for it is only the private sector that can connect today's market demands to immediate product development.

About 59% of the Federal government's $69.7 billion R&D funding in 1993, and about one-quarter of all national R&D related to the mission of defense. Health-related R&D accounted for about 15% of the Federal government's R&D spending, while about 10% went to the space mission.

Only about 4% of Federal R&D spending in 1993 went to civilian industrial technology and less than one percent went to the development of early-stage, pre-competitive civilian technologies. NSF figures show that less than one-tenth of industry R&D funds go to early stage, longer term, higher risk research. The Industrial Research Institute survey of industry R&D performance confirms press accounts that industry is reducing the level of investment in early stage research, with only 8% of firms expecting increases in this category of research in 1995.

The discovery of fundamental new knowledge, basic research, is a vital component of our innovation portfolio. But it is not enough. We have learned over the past twenty years that, all too often, U.S. discoveries of basic knowledge were better exploited by other countries that were better able to develop applicable technologies and transform them into competitive products and services. The market place alone will not invest sufficient resources into mid-and longer-term broad-based technology development needed by the private sector to fully exploit basic knowledge. Our industry-led technology development partnerships are an important link between basic science and private sector commercialization. We should continue to expand these efforts, not abandon them.

Although it is an oversimplification, we can think of basic research as providing the basis for commercial products a decade from now. Industry R&D focuses on short-term product delivery, often no more than 18 months hence. In between are needed efforts to move fundamental knowledge into technologies that industries can turn into new processes and products. In addition, a strong technology base often feeds back into scientific inquiry in a way that leads to fundamental advances in our understanding. Science and technology support one another. The importance of the technology development activities has not been lost on our international competitors. We are meeting the competition through our own industry-led partnerships. We should not abandon them.

Like any portfolio, the mix of R&D activities must reflect a balance between long-term and short-term goals. Good research and development is like a fruit tree; it must be planted years before it can be harvested. Thus, although the private sector does a good job of planting short-term crops, there is insufficient incentive in the marketplace to engage in the development of long-term, higher risk enabling.

The majority of the R&D in which American businesses invest offer strong promises of quick return -- in other words, less risky, product-oriented and bottom-line effective projects applauded by the Chief Operating Officer. Good for business in the short term, but lacking the long-range scope of high-risk but high-payoff technologies that American business must develop to be competitive in the future.

Third, we must examine the extent to which technology, once developed, is actually available to those who can build our nation's economic strength. This goal, of bringing technology to users who can make it work for our country, is as American as the agricultural extension service, perhaps the most successful governmental technology program in our history. Today, that goal is being served through our Manufacturing Extension Partnership, which brings to our nation's small and medium-sized manufacturers access to information resources, and expertise on modern manufacturing technologies and production processes which they need to remain competitive.

Some have argued that more generalized incentives for research and development -- such as R&E tax credits -- are more effective than the Advanced Technology Program (ATP) at encouraging private sector research. I want to emphasize once again that there is no one policy or program that ensures competitive success. The R&E tax credit is an important tool for encouraging greater private sector investment in research and development. That is why the Clinton Administration has supported making the R&E tax credit permanent. However, the R&E tax credit does not differentiate between investments directed toward short-term product delivery and longer term, higher risk investments that will yield products fifteen or twenty years into the future. We need both of these tools as part of our pro-innovation strategy.

Our national capability to engage successfully in international competition is dependent upon our national technological prowess. Where government

should get out of the way, we will. Where government should work in partnership with the private sector, we must do so. Any other course would be to forego a critical element of national competitiveness.

III. Partnering the Growth of Civilian Technology

To meet the challenges that I have outlined, this Administration is committed to providing Americans with the tools they need to meet the challenges of global competition and the need for constant innovation. Our role is to provide an environment which empowers our workers and businesses and communities to embrace change -- with a government that works with them. Just as we provided the traditional tools for success in agrarian and industrial times -- including public education and the basic infrastructure of commerce from the Erie Canal to the national highways systems of this century -- now we must empower Americans with the tools to succeed in a global, high-technology, information-dominated society.

The Department of Commerce's focus on civilian technology has three basic components, each designed to enhance the technological capabilities of American industry. We emphasize:

-- Supporting industry-led technology partnerships,

-- Facilitating the rapid deployment and commercialization of civilian technologies, and

-- Facilitating a technology infrastructure for the 21st Century.

Mr. Chairman, appended to my testimony is a short description of each of our Department's science and technology activities. For purposes of this testimony, however, I would like simply to describe each of the basic components of our policy.

A. Supporting Industry-led Technology Partnerships

Mr. Chairman, I have already described the basic rationale of our Advanced Technology Program -- to address the market gap in our mid- and

long-term R&D portfolio which threatens to make us less competitive in the year 2015 – and beyond.

Governmental action to redress market defects that threaten national prosperity is scarcely novel. For example, the laws establishing intellectual property rights are designed, in a similar manner, to correct market imperfections by establishing rules of conduct that must be obeyed – and, in the international context, that we are working hard to have uniformly adopted.

The ATP program is a carefully-targeted remedy for the problem our nation faces. By sharing the costs of research, it reduces the risk for private businesses, thus allowing them to conduct research and development that might otherwise not be conducted at all – a wise investment for our nation as a whole. Through a rigorous, merits-based review, the ATP program ensures that funded research has both technological and commercial potential. And, with a bottom-up, private sector approach, the ATP program maintains private-sector priorities, not government fiat, as the driving force for technological achievement and focus.

Because of the risk involved, some projects will fail. Others may proceed faster than anticipated. But let me make this clear: it is the company that picks up the cost of product development, not the ATP.

The strength of the ATP – and the reason that it is a solid and successful part of the nation's technology portfolio – is that the program is a true partnership with industry. While government provides the catalyst – and in many cases, critical technical support – industry conceives, cost-shares, manages and executes ATP projects. Management of projects is geared to ensure that the work performed is what industry believes should be done and is what it can do best.

The ATP relies on the substantial involvement of industry to define and implement its R&D programs. ATP research directions are selected based on direct input from industry and developed in consultation with industry. Specific R&D projects are selected from proposals developed and submitted by industry in response to announced competitions.

The ATP emphasizes cost sharing -- ATP recipients on average pay more than half the total costs of the R&D. This ensures that companies have a vested interest in the success of projects and in timely commercialization, that they will engage in the R&D only because it makes sense as a matter of commercial policy. At the same time, participation by small companies and start-ups is made easier by allowing the single applicant's cost share to be its indirect costs, which are usually low. The first four years of the ATP have shown small businesses to be eager participants: of the awards made since 1990, roughly half have been to individual small businesses or joint ventures led by small businesses.

Thanks to strong support from its industrial partners, the ATP already has documented a number of success stories in its short lifetime. Let me tell you about one of these to illustrate how the program works.

Diamond Semiconductor Group of Gloucester, Massachusetts, was a two-person operation with a promising, but unrealized innovation in semiconductor manufacturing. They hoped to develop a new type of ion implantation machine, one of the primary tools of the industry. The new machine would be smaller, faster, cheaper and more accurate than existing devices but it required design breakthroughs considered very difficult. And expensive.

The concept wasn't easy to sell. Diamond's President spent a year and a half looking for funding from U.S. companies, and when that proved unsuccessful, began considering overseas investors. Fortunately, the partners decided to first apply for an ATP award. Their project was one of 21 selected in 1992, and the fledgling company quickly attracted the attention of Varian Associates, one of the largest suppliers of ion-implantation equipment in the world.

Under the ATP award, Diamond developed their concept and convinced Varian to purchase a worldwide license to manufacture, sell and service devices based on this technology. And then Varian began funding the product development, an area not covered by ATP awards.

Today, Diamond has 35 full- and part-time employees. The partners credit the company's success -- and in fact, its very existence -- to the

ATP award for a high-risk technology that only became attractive to a private-sector investor once it was shown to be feasible.

Early results indicate that the ATP is successfully improving the capability of the nation's businesses to capture economic returns from scientific and technological innovations. Two independent studies of projects funded in FY 1991 revealed substantial, early beneficial impacts on participating companies, including expanded R&D activity, particularly the ability to engage in high-risk, long-term research with high-payoff potential; cost and time savings, improved productivity, and other benefits from industry-industry, industry-government, and industry-university collaborations; improved competitive standing; formation of valuable strategic business alliances; improved ability to attract investors; assistance in converting from defense to commercial applications; and acceleration of technology development, leading to improved market share.

This is how the ATP fulfills an industry need that no other government or private-sector program can fill. By funding enabling technologies that most investors consider too risky, the ATP provides U.S. businesses with a bridge from today's innovative promises to tomorrow's breakthrough products and processes.

When I came into office, I said that if John Major or Francois Mitterand could travel around the world advocating on behalf of their nation's products, we could as well. And we have done just that. Here, too, why should we stand by and watch other nations prepare themselves for the future -- making their nations more attractive to the pursuit of long-term technologies, with the attendant economic benefits that brings, while we stand by inactively? We should not. Scaling back Federal investment in long-term, high-risk technology R&D is tantamount to unilateral disarmament in a fiercely competitive world marketplace.

B. Facilitating the Rapid Deployment of Civilian Technologies

Stimulating the development of innovative technologies is one-half of the equation. The other half -- getting new and existing products to market in a timely, cost-effective competitive basis -- is also critical if U.S. firms are to succeed in the global marketplace.

As part of those efforts, the Administration fully recognizes the fundamental role that our 370,000 small- and medium-sized manufacturers play. These firms are the source of two-thirds of our manufacturing jobs, account for 75 percent of new manufacturing jobs -- and contribute more than half the value-added in manufacturing in the U.S.

These facts advocate for expansion of the Manufacturing Extension Partnership (MEP) -- and for the potential that this program has to make a difference. The success of the agricultural extension service over the last 100 years in building an agricultural industry that is the envy of the world -- is a strong precedent for the MEP.

Today there are 44 extension centers already operating or soon to be operating in 32 states. By achieving the President's goal -- to establish a nationwide network -- the nation's 370,000 small and medium-sized manufacturers will have easy access to modern manufacturing technologies, production techniques and best practices through the MEP national system.

The network of manufacturing extension centers is growing because the centers are industry-driven, responsive, and focused on positive bottom-line impacts. Each center tailors its services to meet the needs of manufacturers in its region. And it is the centers' customers who indicate the impact those services have on their firm's performance -- in terms of sales, capital spending, inventory costs, productivity, and other bottom-line factors. The results are staggering. A recent analysis found that the economic benefits to client firms -- in terms of enhanced responsiveness to customer demands, reduced waste and inventory, and increased sales -- resulting from assistance from a center exceed the Government's cost at a rate of seven to one.

Manufacturing extension services are supported by governors, mayors, and CEOs because they understand the unique barriers facing small and medium-sized manufacturers and the need for making appropriate technology, information and resources more accessible to them. Historical experience indicates that smaller manufacturers cannot easily overcome these barriers without external assistance. Furthermore, the extension services provide essential customization of new technologies and process applications adapted to firm-specific operating environments. They also understand the

prospective payoff of such services – and the prospective losses, if these companies do not make the changes needed to remain competitive.

C. Facilitating a Technological Infrastructure for the 21st Century

For nearly a century, the primary responsibility for the constitutional mandates to "fix weights and measures" has fallen on the research laboratories of the National Institute of Standards and Technology, the only federal laboratory specifically commissioned to work with U.S. industry toward improving U.S. competitiveness. The laboratory research program at NIST is a crucial component in this Administration's strategy for competing successfully in the critical industries of the 21st century. Infrastructural technologies such as measurement methods, fundamental standards, materials property data, testing techniques, and advanced instrumentation provide manufacturers with the essential tools to continuously improve both their products and processes. NIST infrastructural technologies also speed market acceptance of advanced technologies by providing buyers and sellers with objective and technically sound methods with which to agree upon and assure product characteristics and performance. In order for U.S. industry to be able to implement changes necessary to remain competitive in the global marketplace, these basic tools require constant improvement. Without this continued development, U.S. firms in many emerging high-technology fields – such as biotechnology, optical electronics, advanced manufacturing and materials, and high-performance computing and communications – will lack the underlying measurement technologies and standards necessary to make quality products for future global competition.

NOAA is an integral part of the Department's technology R&D portfolio. NOAA's science has played an important role in U.S. strides in achieving improvements in environmental quality, managing natural resources more wisely, and understanding and predicting the behavior of earth systems so as to ensure sustainable economic opportunities. NOAA's scientific research supports its two missions - Environmental Assessment and Prediction, and Environmental Stewardship.

NOAA assesses and predicts environmental changes on different time scales. NOAA improves its short term weather forecasts through research into basic hydrometeorological processes and through the development of new

observational technologies, such as doppler radar. Future improvements in forecasts and warning services will continue to enhance U.S. capabilities to mitigate adverse environmental conditions impacting safety and productivity, from managing evacuations during hurricanes to routing airplanes efficiently.

NOAA's research into the El Nino-Southern Oscillation phenomenon has led to the development of experimental seasonal climate forecasts. By the year 2015, NOAA should have the capability to produce multiseason forecasts of precipitation with accuracies approaching those of current short-term forecasts.

Long-term changes in the global environment may alter the capacity of the Earth to sustain life. NOAA's research involves documenting and understanding these changes, leading to the development of models for their prediction. NOAA's basic research into atmospheric chemistry has led to immediate solutions for mitigating ozone depletion in the Earth's atmosphere. NOAA research on climate change will provide the basis for forecasts of decadal and longer changes with predictions of sufficient scientific credibility to support decisions.

NOAA's second major mission is stewardship of the coastal environment. NOAA's stewardship responsibilities include building sustainable fisheries, recovering protected marine species, maintaining healthy coastal ecosystems, and providing navigation and positioning services. NOAA is conducting and integrating the results of research efforts in multiple fields to better manage its responsibilities in these areas.

These efforts include improving fishery stock assessments using new technologies, such as hydroacoustics; and conducting habitat and marine biodiversity studies which will aid in recovering a number of protected marine species, such as the salmon in the Pacific Northwest. As coastal populations grow rapidly, NOAA is providing information for management decisions designed to promote sustainable economic growth in coastal regions, and to restore and conserve coastal ecosystems.

NOAA will meet national needs for improving navigation and positioning services. By exploiting emerging technologies, such as the Global Positioning System, NOAA will produce and integrate chart data, based on satellite

geodetic positioning, and will improve a number of data products for clients who can utilize this real-time environmental information.

In addition to NIST's and NOAA's infrastructure work, the development of the National Information Infrastructure (NII) and its counterpart, the Global Information Infrastructure (GII), is a top priority. These initiatives will promote a stronger economy, more competitive businesses, more effective government, and better educational and technological leadership. The private sector is constructing the NII and GII. The Federal government is acting as a catalyst to promote its development and to ensure that the initiatives are accessible and affordable to all Americans. The Administration's NII and GII initiatives seek to ensure that all Americans can take advantage of the opportunities brought by the advanced information technologies and services -- a market that approaches 10 percent of our domestic economy.

The Commerce Department is focusing on a number of goals, chief among them are privatization and liberalization of markets, open standards, protection of intellectual property rights, regulatory flexibility, government advocacy and stimulating innovative applications. As a means of facilitating the private sector's development and use of NII applications to advance the public good, the Administration is funding NII demonstration projects such as telemedicine and distance learning. Last year the Commerce Department made its first competitive awards under the Telecommunications Information Infrastructure Assistance Program (TIIAP). The program is providing matching funds to state and local governments, nonprofit health care providers, school districts, libraries, universities, public safety services, and other non-profit entities in 44 states, the District of Columbia and the Virgin Islands. The TIIAP will help demonstrate to Americans at the local level the advantages of having access to modern, interactive information infrastructure.

I firmly believe that if you look:

- at what our policies and programs are striving to accomplish,
- at how they are being driven by private sector needs and by their contribution to reaching our society's goals, and
- at the results that we are beginning to deliver,

you will come to the conclusion -- and agree -- that these efforts are making a real contribution.

You asked me to put our efforts in the context of how they will make a significant difference twenty years from now. Twenty years ago, we would have been hard-pressed to predict the stunning advances in science and technology that are transforming our workplaces and our lives. Today, there is no such thing as "business as usual," and we must adapt to the quickening pace of change in technologies and our economy. Our work at the Commerce Department is designed to make sure that American businesses and American works prosper both today and in the decades ahead.

IV. Conclusion -- The Role of the Department of Commerce

I would be remiss, Mr. Chairman, if I concluded without discussing another implication of the new economic challenges our nation faces.

In an era of re-inventing government, some have questioned the nature of the activities housed in, or even the existence itself, of the Department of Commerce. Such criticism usually focuses on the differences between the activities that I oversee: fisheries management and manufacturing centers; export promotion and control, and domestic economic development; the Census Bureau and minority business enterprise; and weather forecasting and economic statistics.

To emphasize the differences is, however, to miss the point. If my testimony today has emphasized anything it is this: We live in an increasingly competitive global economy in which all aspects of economic competitiveness are integrally connected. Trade policy opens opportunities for high-technology companies. Technological proficiency is a key ingredient to economic development in the United States. Economic development will often turn on our ability to sustain environmental resources and provide a predictive capability for environmental change. Measuring and monitoring resources is an important part of the economic information that we collect and the economic analysis that we perform.

The Department of Commerce is where these connections are made. We focus on economic growth and competitiveness and, within our ten bureaus, we

work, in a myriad of ways, toward the complementary goals of economic growth, job creation, an increasing standard of living, and environmental protection. And we work better, in every respect, because we are, every day, confronted with the intersection of trade promotion, civilian technology, economic development, sustainable development and economic analysis.

That intersection is where the future of the United States economy is being fashioned, every day, by entrepreneurs who forge our future one deal, one contract and one transaction at a time. My Department works with them every day, to our mutual -- and our future -- benefit.

Thank you.

Appendix

THE DEPARTMENT OF COMMERCE SCIENCE AND TECHNOLOGY ACTIVITIES

THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Introduction.

The National Oceanic and Atmospheric Administration (NOAA) has set forth a vision for the year 2005 of a world in which societal and economic decisions are coupled strongly with a comprehensive understanding of the environment. NOAA's mission is to describe and predict changes in the Earth's environment, and conserve and manage wisely the Nation's coastal and marine resources to ensure sustainable economic opportunities.

Over the past 25 years, the U.S. has made important strides in improving environmental quality, managing natural resources more wisely, and understanding and predicting the behavior of Earth systems. NOAA sciences and services have played an important role in this evolution. As we approach the 21st century, we face continuing and complex environmental challenges. In the next twenty years, investments in science and technology will revolutionize these national services, with returns on investment through economic growth and improvements in the quality of life.

NOAA's Strategic Plan.

NOAA's Strategic Plan for 1995-2005 defines the goals necessary to fulfill our vision. The plan transcends internal organizations, and promotes synergy, innovation, cooperation and efficiency. The program strategy consists of seven inter-related goals. The seven goals are grouped under our two primary missions of *Environmental Assessment and Prediction* and *Environmental Stewardship*. Achievement of our goals depends strongly on NOAA's capabilities as a national resource for environmental research, observational systems, and data and information systems.

Environmental Assessment and Prediction

Advance Short-Term Warning and Forecast Services. Our dynamic environment presents extraordinary challenges for protecting life and property. NOAA is improving its short-term forecast and warning products by enhancing abilities to observe, understand, and model the environment, and by effectively disseminating products to users. NOAA research contributes to this goal through advancing basic hydrometerological understanding and the development of new observational technologies. Significantly improved short-term forecast and

warning services will be implemented for the global environment that will enhance capabilities to mitigate adverse environmental conditions impacting safety and productivity.

Implement Seasonal to Interannual Forecasts. This month, the National Meteorological Center will begin issuing experimental seasonal climate forecasts for the contiguous U.S. and Alaska. This capacity is the direct result of research performed over the last decade on the El Nino-Southern Oscillation, or ENSO, phenomenon, and of key new observing capabilities. Seasonal forecasts will lead to immediate benefits, especially in the agriculture and water resource management sectors. The terrible flood of 1993, and the loss of returning salmon in the Northwest, have been connected to El Nino events. By the year 2015, we should have the capability to produce multiseason forecasts of precipitation with accuracies approaching those of current short-term forecasts.

Predict and Assess Decadal to Centennial Change. Long-term changes in the global environment may alter the capacity of the Earth to sustain life. Prediction and assessment on decadal-to-centennial time scales will require: improved process understanding; operational observations of global changes; and improved global models providing predictions. NOAA research on ozone chemistry is having immediate payoffs for industry and is providing input to international assessments. NOAA research on climate change will provide the basis for forecasts of decadal and longer changes with predictions of sufficient scientific credibility to support action.

Environmental Stewardship

Build Sustainable Fisheries. NOAA is implementing programs to restore the wealth of U.S. fisheries. Current investments in biotechnology, sampling technology, and ecosystem dynamics research will make a significant difference in how NOAA addresses this rebuilding. Better understanding and knowledge leads to sustainable fisheries and enhanced economic opportunity for the country.

Recover Protected Species. NOAA must protect and plan for the restoration of marine species threatened with extinction. Principal research paths include improving stock assessment methodologies and genetic approaches to stock identification. The goal is to recover protected species in danger of extinction in a manner compatible with sustainable use of marine resources.

Coastal Ecosystems Health. As coastal populations grow rapidly, NOAA is providing the research, monitoring, assessments, predictions and guidance for management decisions designed to promote sustainable economic growth in coastal regions, and to restore and conserve coastal ecosystems. NOAA's coastal research

efforts build on existing strengths in coastal water quality, habitat and marine biodiversity. Improved environmental indicators and integrated coastal management will, for the year 2015, support an ecosystem-wide approach toward coastal ecosystem health and prosperity.

Modernize Navigation and Positioning Services. NOAA is exploiting emerging technologies and redefining its products and services to meet the Nation's need to produce and integrate chart data, satellite-based geodetic positioning, and real-time environmental information. NOAA will supply, in the 21st century, improved positioning services to ensure the safety of life, property and the environment, while supporting economic growth.

National Capabilities.

Along with research, NOAA must continue to invest in its capabilities as a national resource for observational systems and environmental data and information services. We must seek to implement an integrated global observing capability, while ensuring that data are processed, analyzed, and distributed in a timely fashion.

THE TECHNOLOGY ADMINISTRATION (INCLUDING NIST)

The Office of Technology Policy

The purpose of the Office of Technology Policy is to improve U.S. industry competitiveness. It fulfills its mission by advocating policies which empower the private sector to compete, and implementing and managing Congressionally mandated programs that increase U.S. companies access to the best foreign science and technology. OTP also serves as a technology policy think tank.

Through extensive interaction with the private sector, and an "industry as customer" focus, OTP has determined that a comprehensive policy approach to US competitiveness is essential. Such an approach must address the broad range of factors that impact the ability of companies to develop technology, turn it into products and services, and bring them to the global marketplace.

OTP, in partnership with private-sector leadership, is evaluating and promoting policies that promote competitiveness and economic growth. This includes efforts to:

I. Improve the business climate for private-sector innovation and investment.

II. Improve the efficiency and effectiveness of Federal civilian technology efforts to maximize their impact on competitiveness, economic growth, and job creation. The focus is "industry as customer."

OTP is striving to become a "first stop" for the private sector in its efforts to work with the federal government on issues affecting industrial competitiveness. Its attention has been focused on orchestrating efforts across the federal government or acting as a catalyst and facilitator for industry action.

Business Climate Initiative.

The Business Climate Initiative seeks to promote the enhancement of the overall climate for technological innovation by identifying, exploring, and advocating policy reforms. Starting by listening to the concerns and recommendations of private industry, this initiative provides a forum and a vehicle for constructive consensus-building around a variety of changes -- regulatory, capital formation, and other policy areas -- in order to improve U.S. industrial competitiveness. Whether through immediate administrative modifications or more structural statutory and regulatory reforms, the Business Climate Initiative will give credibility and coherence to the federal government's efforts to improve the U.S. business environment on the basis of industry's priorities.

International Policy Projects.

OTP is working to ensure that U.S. firms have access to the foreign science and technology programs that will strengthen their ability to compete in today's global markets. It does this through the identification, gathering, and dissemination of valuable but not easily available science and technology information -- such as that on developments in Japan -- and by helping place U.S. engineers in Japanese manufacturing companies for extended periods of time under the Manufacturing Technology Program. OTP is also responsible for the development of new forms of international collaborative scientific and technological activities that will enable U.S. firms to benefit from the expertise available in other countries. Collaborative agreements include the Intelligent Manufacturing Systems Program and the U.S.-Israel Science and Technology Commission, as well as programs that support foreign policy initiatives such as those with Northern Ireland and Egypt.

Manufacturing Assessment Study.

OTP is assessing the health of the nation's manufacturing base. This assessment is intended to provide insight on the make up and geographic distribution of manufacturing firms in the U.S. This work is being conducted with the Center of Economic Studies

within the Census Bureau to compile statistics derived from the Census of Manufacturers. Input from individual industry trade associations and state and regional manufacturing assistance organizations also has been collected. The report will be released in the first quarter of 1995.

Benchmarking Industrial Competitiveness.

At the firm level, the practice of "benchmarking" one's operations against those of competitors is a well-established means of assessing and improving competitiveness. At the industry level, a number of industry associations and university research centers around the country have undertaken the task of benchmarking "competitiveness" that is, an industry's ability to sell at a profit its goods and services under free and fair market conditions, worldwide.

One objective of this OTP initiative is to expose a broader cross section of industry to the potential benefits of conducting benchmarking exercises. Another is to identify potential government information sources for such exercises and where appropriate, improve the types of information provided by government to the private sector for this purpose. Finally, our staff is examining on an industry-by-industry basis, the relationship between regulatory, tax, trade, and technology policies, as a direct response to concerns voiced by industry over the seemingly ad hoc and sometimes contradictory nature of government policies.

Efforts are currently underway in twelve sectors to prepare initial competitiveness benchmarking reports. These efforts are all characterized by cooperation between government, industry and academia, and involve more than 100 of the country's leading experts in matters of industrial competitiveness. The draft reports will be reviewed by panels of industry and academic experts, beginning in the spring of 1995, and will be issued in final form by the end of the year.

Federal Partnerships Project.

It has been almost fifteen years since the Federal government first began addressing issues of competitiveness through public private partnerships. OTP is evaluating the effectiveness of these various partnership models and developing metrics of success for these programs. Once again, the report will be founded on the experiences of the private sector in working with the various programs, drawn from roundtables with the private sector companies and industry associations. The report will present profiles of the programs, their funding, constituencies, key features, and key issues.

The National Institute of Standards and Technology

NIST's primary mission is to promote U.S. economic growth by working with industry to develop and apply technology, measurements, and standards --providing the basic technical infrastructure needed by U.S. industry. Both small and large companies are assisted by NIST. NIST's priorities are set and results are measured on the basis of benefits realized by the U.S. economy.

NIST's appropriation of $855M in FY95 -- the only portion of the federal budget explicitly devoted to enhancing industry's critical technology infrastructure needs -- is just over one percent of federal R&D and less than one-half of one percent of the nation's total R&D expenditures.

NIST carries out its mission through a portfolio of four major programs which are described below.

NIST Laboratory Programs.

For nearly a century, researchers at NIST laboratories have supported the growth and competitiveness of U.S. industry by providing high-quality, science based measurement and standards research and services. The NIST laboratories serve the needs of large and small companies and individuals from virtually all sectors of the economy. Laboratory efforts are planned and conducted in cooperation with industry and focus on infrastructural technologies such as measurements, standards, evaluated data, and test methods which provide a common basis for science, technology, and commerce.

NIST provides vital elements of the measurement and technical infrastructure which makes possible much of the development, production, distribution, and sales of manufactured products. NIST laboratories support the U.S. economy in three critical ways:

I. By providing measurement technologies, evaluated data, materials characterizations, and test methods, NIST furnishes industry with an organized, verified technical infrastructure which firms depend upon to predict, perform, measure, and analyze ever more complex and technical activities in a rigorous, effective, and timely manner.

II. NIST labs work with industry to develop and maintain technologies and services - from advanced process and quality control measurements, to improved test and measurement methods, to national reference standards and calibration services - that enhance U.S. industry's ability to provide high quality, competitive products and services.

III. By working with industry as a non-regulatory, unbiased third-party to develop technical underpinnings for standards, establish conformance tests, and facilitate the private-sector voluntary standards process, NIST accelerates market development and increases the efficiency of market transactions by promoting improved communication, consistency, and trust among technology buyers and sellers.

The benefits from this work are spread across many companies and industries. Industry traditionally under-invests in development of these infrastructural technologies because they are used simultaneously by many firms and typically are not embodied in products, making it difficult or impossible for individual firms/industries to recover the R&D investments.

The NIST research programs are carried out in eight major Laboratories, with specialized products and services offered through a Technology Services unit.

The **Electronics and Electrical Engineering Laboratory** (EEEL) provides the fundamental basis for all electrical measurements in the U.S. In consultation with industry, researchers tailor programs to meet the most critical measurement needs in the manufacture of semiconductor, magnetic, RF, microwave, optical, optoelectronic, and superconducting products, as well as electrical power systems. These researchers develop improvements in quality control and cost effectiveness for both current and next-generation semiconductors; produce methods that help increase the efficiency of optical fiber networks; and operate specialized computer facilities to develop new standards and performance measures for flat-panel displays and high-definition television systems.

The **Manufacturing Engineering Laboratory** (MEL) has primary responsibility for maintaining the national standards for dimensional metrology. Researchers in MEL are helping to develop many of the tools for automated intelligent-processing systems that will soon be the core of all world-class manufacturing operations. These components include intelligent machines; advanced sensors for real-time in-process measurements; software for precision control of machine tools; and information technology for integrating all elements of a product's life cycle, from planning and design through marketing and customer support. MEL also provides technical support for industry groups that develop standards for measurements, measurement techniques, hardware, software, and data interfaces.

The **Chemical Science and Technology Laboratory** (CSTL) maintains the national system of chemical measurement and coordinates the system with those of other nations. CSTL also develops the calibration and measurement standards for a wide range of instruments and processes important to the chemical-

manufacturing, energy, health-care, biotechnology, food-processing, and materials-processing industries.

The **Physics Laboratory** (PL) attends to the long-term needs of many U.S. high-technology industries. PL conducts basic research in the areas of quantum, electron, optical, atomic, molecular, and radiation physics. This research includes, for example, efforts to improve the accuracy and precision of time and frequency standards. Much of the laboratory's research is devoted to overcoming the measurement barriers to the next technological revolution, in which individual atoms and molecules will serve as the fundamental building blocks of electronic and optical devices.

Programs in the **Materials Science and Engineering Laboratory** (MSEL) cover the full range of materials issues, from design, to processing, to performance. The unifying aim is to acquire the knowledge and tools needed for intelligent manufacturing methods with real-time, automated process controls. Special research initiatives address ceramics, metals, polymers, composites, and superconductors. This research supports efforts by U.S. industry to develop reliable, low-cost manufacturing methods for producing tailor-made materials and products with superior properties.

The major goals of the **Building and Fire Research Laboratory** (BFRL) are to improve the productivity of the U.S. construction industry. Through performance prediction and measurement technologies, as well as technical advances, the laboratory works to improve the life-cycle quality of constructed facilities. The laboratory studies building materials; computer-integrated construction practices; structural, mechanical, and environmental engineering; and fire science and fire safety engineering. Products of the laboratory's research include measurements and test methods, performance criteria, and technical data that are incorporated into building and fire standards and codes.

The **Computer Systems Laboratory** (CSL) benefits both users and manufacturers of computer and telecommunications technology. Its research and testing programs foster the orderly development of an "open systems" environment intended to make all forms of information technology compatible and interoperable. For manufacturers of hardware and software, industry-wide adoption of standards expands marketing opportunities, and users are freed of the constraints and frustrations of incompatible proprietary systems. Much of CSL's work consists of advising and assisting industry in developing standards that satisfy user needs and yet accommodate innovations that differentiate the products of competing vendors.

The **Computing and Applied Mathematics Laboratory** (CAML) develops mathematical, statistical, and state-of-the-art scientific computing tools that help NIST researchers and their

collaborators in U.S. industry accomplish their research and measurement objectives. NIST mathematicians and statisticians also support U.S. industry through computer-aided modeling of complex manufacturing processes and statistical methods for improving the quality of products and processes. Other research programs focus on advanced computer graphics programs that produce two- and three-dimensional visualizations of complex problems; new methods for displaying, manipulating, analyzing, and transmitting large volumes of data; and software applications for harnessing the problem-solving power of parallel processors.

Through **Technology Services** (TS), NIST provides a conduit to a wide variety of services and programs to help U.S. industry improve its international competitiveness, commercialize new technologies, and achieve total quality in all facets of business operations. Companies spanning all industrial sectors depend on the precision and reliability of NIST measurement services and products to keep their production processing smoothly, efficiently, and safely. NIST reference materials, data, and calibrations help industry maintain quality control in the production of everything from aerospace alloys, to voltmeters, to breakfast cereals. Responding to increased emphasis on quality standards in international markets, NIST provides information and assistance to about 20,000 organizations and individuals every year concerning national and international voluntary and regulatory product standards and certification systems.

Setting Priorities. NIST programs are guided by measurement and evaluation systems which are used to set priorities, evaluate operational performance, and assess near- and long-term returns on investments and activities. Priorities are set, and results measured, on the basis of benefits realized by U.S. industry. Priorities in NIST's laboratory are set in consultation with industry and in accordance with several guiding criteria including the magnitude and immediacy of industrial need; the degree of correspondence between particular industrial need and NIST's mission to develop and support infrastructural technologies; opportunity for NIST participation to make a major difference; nature and size of the anticipated impact; NIST's capability to respond in a timely fashion and with a high-quality solution; and the nature of opportunities afforded by recent advances in science and technology.

Measuring Results. NIST laboratories use a variety of measures to track and evaluate performance, including the value and utility of research deliverables and services. Customer feedback, gathered through many mechanisms, is the principal source of evaluative information. NIST's primary "deliverables" - measurements, standards, evaluated data, process models, etc. - are made widely available to U.S. industry, usually in the form of technical information or publications. Measures of the relevance and value of this information include

industry attendance and level of participation at NIST's technical workshops; commercialization of products incorporating results of NIST R&D; application of NIST R&D results to industrial processes; level of industry commitment to NIST projects and consortia; number of guest researchers from industry; and repeat customers.

Developing methods for measuring and quantifying the impact of tax payers' investment of resources in NIST's laboratories has very high priority. NIST has been at the forefront of efforts to develop methodologies for assessing the economic impact of laboratory research and has undertaken a series of assessments to determine the economic impact of selected laboratory programs and services. Using a method based on internal rate of return calculations used in industry, these impact studies, conducted by third parties, are used to assess the value of U.S. tax payers' investments in those programs. Since only measurable benefits are included, the studies provide conservative estimates of impact. Nevertheless, these studies indicate that the aggregate return from investment in NIST laboratory research programs is twice the return for private-sector innovations and ten times the average return on capital investment in the U.S.

Areas of Increasing Emphasis. In anticipation of an information revolution expected to rival industrial revolution in social impact, NIST is planning the establishment of a new Information Technology Laboratory whose mission is to develop and support measurement technologies, standards of interoperability, etc., in support of the National - and Global - Information Infrastructure.

A major component of the information revolution will be the continued evolution of semiconductor and magnetic storage devices. Existing technologies for production and characterization of these devices are approaching ultimate limits imposed by material properties and physical laws. NIST has established the National Semiconductor Metrology Program to address problems of fundamental metrology which must be solved in order for semiconductor industries to meet the demands of the 21st century.

As device miniaturization progresses toward 2015, we will soon need to build and characterize devices whose typical size is just a few atomic diameters. There currently are profound limitations to our ability to measure, fabricate, characterize, and understand atomic scale devices. NIST has begun a new nanotechnology initiative specifically to enhance our current capabilities to make and study nano-structured materials.

Because of very rapid advances in the field of biotechnology, the real industrial need for critical new measurements and standards is growing faster than are the underlying measurement

technologies. To provide the infrastructural support to enable these technologies to grow, we have initiated a program in Biotechnology.

As social pressures increase to monitor or mediate the long term effects resulting from increasing environmental stress of the growing human population, it is essential to provide substantially improved measurement technologies with sufficient sensitivity, accuracy, and reliability that definitive studies can be performed. Long-reaching policy decisions concerning use of precious resources must not be made on the basis of conflicting and inadequate experimental data. To address these crucial measurement needs, we have initiated a program in Environmental Technology.

Manufacturing Extension Partnership (MEP).

The MEP helps small and medium-sized companies succeed in the marketplace by helping them to improve their operations by adopting new technologies. These businesses typically lack the ability to absorb new manufacturing technologies straight from the lab into their operations.

There are more than 370,000 U.S. companies with fewer than 500 employees, accounting for about 95 percent of all U.S. manufacturing plants. These companies are assisted through MEP's growing nationwide network of affiliated manufacturing extension centers run by and built on local, state and non-profit groups that provide hands-on technical assistance to small manufacturers.

The MEP takes maximum advantage of programs already in place, avoiding duplication of efforts among existing technology assistance organizations; it concentrates on matching company needs to the best available help from the private sector, state, local or federal government, regardless of source. Company benefits from formal technical assistance from MEP extension centers totalled $320 million between 1989 and 1992 - a return of over $7 on each federal dollar invested.

Advanced Technology Program (ATP).

It is a rigorously competitive program which invests in cost-shared research by individual companies or industry-led joint ventures. The sole aim is to develop high-risk, potentially high-payoff enabling technologies that otherwise would not be pursued because of technical risks and other obstacles that discourage private investment. These obstacles to private-sector investment include high technical risk, prohibitive cost, long pay-back horizons, or anticipated returns not specific to individual firms or distinct industrial sectors. The ATP is market-oriented. While government provides the catalyst -- and

in many cases, critical technical support -- industry conceives, manages, and executes ATP projects. ATP support is strictly limited to pre-product development that is high risk, and ATP will not support any product development. Because of the risk involved, some projects will fail. Others may proceed faster than anticipated, and intermediate products may appear even before the project ends. But NIST only cost-shares on the R&D tasks. Whether the commercialization begins to take place before the ATP project ends or long after, the company must pay 100% for designing specific products incorporating the technology and any costs associated with commercialization.

Commercial firms know best how to commercialize a promising new technology. With this in mind, the ATP funds for-profit companies. Small, medium, and large companies, and joint ventures led by two or more companies, are eligible for direct funding. Successful ATP project sponsors range in size from start-up companies with a handful of employees to major industrial firms with international scope. Universities, federal laboratories, and non-profit independent research organizations participate in many ATP projects, but as subcontractors or as members of joint ventures (non-profit independent research organizations may administer joint ventures). The ATP has a comprehensive plan for monitoring and evaluating its performance.

ATP project goals are clear: they are expected to result in U.S. companies developing new product lines, hiring new employees, capturing more world market share, and prospering so that our economy grows faster, resulting in increased tax revenues.

NIST Quality Outreach Program.

By the 1980s, it was clear to many industry and government leaders that a renewed emphasis on quality was no longer an option for American companies but a necessity for doing business in an ever growing world market. As a result, the Malcolm Baldrige National Quality Award was established by Congress in 1987 to promote quality awareness, to recognize quality achievements of U.S. companies, and to publicize successful quality strategies. The award is *not* for specific products or services. Two awards may be given annually in each of three categories: manufacturing, service, and small business. In conjunction with the private sector, the National Institute of Standards and Technology developed and manages the award program.

Businesses located in the United States may apply for the award. Those that do must undergo a rigorous evaluation by an independent board of examiners composed of private- and public-sector experts in quality. The examination includes onsite visits for those passing an initial screening. Each applicant receives a written summary of strengths and areas for improvement in quality management.

Seven broad categories make up the criteria: leadership, information and analysis, strategic planning, human resource development and management, process management, business results, and customer focus and satisfaction. Applicants for the award must provide data to show quality achievement and quality improvement in each area.

A General Accounting Office report calls the award criteria "the most widely accepted formal definition of what constitutes a total quality management company." Almost 1 million copies of the criteria have been distributed. Thousands of organizations use the criteria as a quality improvement "road map." In addition, about 30 states have established—or will establish soon—state quality awards programs, most of which are modeled after the Baldrige Award.

While quality management cannot guarantee success, the Baldrige award winning companies and many others believe that investing in quality can lead to outstanding returns, both for individual companies and the country. According to a recent report by the Conference Board, a private business membership organization, "A majority of large U.S. firms have used the criteria of the Malcolm Baldrige National Quality Award for self-improvement, and the evidence suggests a long-term link between use of the Baldrige criteria and improved business performance."

NATIONAL TECHNICAL INFORMATION SERVICE

Introduction.

The National Technical Information Service (NTIS) is a self-funded government agency under the Department of Commerce. For nearly 50 years, all of our costs associated with collecting and disseminating the Nation's collection of scientific, technical, engineering and business information are paid for by the sale of our products and services.

NTIS offers customers a broad range of information in different formats that is available no place else. Over 200 U.S. government agencies contribute about 12,000 documents per month to the NTIS collection. NTIS currently holds over 2.5 million documents in the collection. In 1992 Congress passed the American Technology Preeminence Act (ATPA) which mandates that all Federal agencies submit their public scientific, technical, engineering and related business information to NTIS. This has significantly increased the breadth and depth of our information products.

FedWorld.

FedWorld is an on-line information service established by NTIS in 1992 to provide the general public with a user-friendly, central resource for government information. FedWorld provides both

dial-up and Internet access. Today, there are over 120,000 registered users that access everything from White House press releases to the Security and Exchange Commissions' investment advisory's to the National Cancer Institute's Cancer research or treatment information.

In addition to the databases described above, FedWorld also allows users to "gateway" through the system to over 130 other publicly available government information systems. This effectively provides for a "one-stop" electronic shopping mall of numerous types of government information.

Automated Document Storage and Retrieval System (ADSTAR).

NTIS has moved into the electronic input, storage, and retrieval environment. Automated Document Storage and Retrieval (ADSTAR) is the information management system that will tie together the optical character readers and scanners with the full-text database systems, optical disk library system, CD-ROM production system with the FedWorld data link and the remote printing capabilities.

At the present time, we have successfully implemented the concept to scan documents into the image storage system and retrieve them on demand. These documents can then be printed in paper, microfiche, or converted to character read material and formatted to meet customer needs -- even custom CD-ROM's. This new system will be integrated order processing and billing systems and significantly improve our ability to satisfy customers and reduce costs.

Other NTIS Services.

Fax Management (both inbound transmissions and outbound transmissions); Freedom of Information Act (FOIA) fulfillment; production services, patent licensing services, business partnerships and joint ventures are other services NTIS offers other government agencies. For nearly 50 years, NTIS has been the cost effective alternative to help federal agencies improve their own information activities.

THE BUREAU OF EXPORT ADMINISTRATION

Critical Technology Assessments.

BXA is the departmental lead for conducting in-depth assessments on the financial status and production capabilities of industries and technologies critical to current and future defense systems. These assessments provide industry and government with comprehensive information and analysis on the performance and competitiveness of critical technology firms, an important

function in light of declining defense budgets. While these technologies are essential to developing next generation defense systems, they are also dual-use in nature and crucial to our ability to compete in the global economy. Examples of recent assessments include artificial intelligence, advanced ceramics, advanced composites, superconductivity, and optoelectronics. Additional assessments are underway in semiconductors and software.

Competitive Enhancement Program.

BXA is leading a unique interagency effort to enhance the competitiveness of specific subsectors that have been hurt by imports but are nonetheless vital to our economy. This program evaluates the strengths and weaknesses of targeted subsectors, introduces potential customers to manufacturers, and provides a comprehensive response to the specific needs of that subsector. BXA assembles teams of government experts and end-users to visit manufacturers and then to apply the expertise and resources of the team members to help the manufacturers facing competitive challenges.

To date, this interagency effort has addressed the competitive concerns of three electronics subsectors: semiconductor brazed pins, copper tungsten heat sinks, and aluminum silicon carbide. In the first two cases, domestic firms are facing foreign competitors with advantages in price, technology, or manufacturing capabilities. In the last case, the United States is in a position to take a leadership role in this emerging technology. BXA is reviewing additional subsectors.

Fostering Joint Technology Ventures with the Former Soviet Union.

The Department of Commerce is also a catalyst in spurring technology relationships between U.S. industry and defense establishments in the former Soviet Union (FSU) that will both enhance our competitiveness and assist economic conversion in those states.

The lack of market driven cost restraints has resulted in FSU research programs pursuing many technological paths of that were prohibitively expensive to western market-based economies. The results and knowledge base now provide the opportunity for exploring new commercial applications for this base of research and "know how."

The Bureau of Export Administration as Vice-Chair of the Defense Conversion Commissions with Russia, Ukraine, Kazakhstan, and Belarus, has taken a lead role in researching and disseminating to U.S. industry information on FSU technology. In addition, BXA provides information on how to develop joint research

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relationships and referrals to appropriate U.S. agency programs for assistance in financing these ventures.

Economic Impact Analyses.

Export controls on technologies that have both military and commercial applications can adversely affect U.S. industry, particularly high technology sectors, by excluding U.S. firms from certain markets. In response to the mandate of the Trade Policy Coordinating Committee, the Bureau of Export Administration developed a new initiative in October 1994 to analyze the impact of export controls on U.S. industry and to ensure that economic factors are considered in export control decisions. The goal of this program is to remove export controls that are not serving their intended security purposes and are hindering our competitiveness in world markets.

THE NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION

National Information Infrastructure and Global Information Infrastructure.

The Federal Government is acting as a catalyst to promote the private sector development of the NII and GII. The NII and GII will directly contribute to a stronger economy, more competitive business, more effective government, and better educational and technological leadership. NTIA is the agency within the Department of Commerce that supports the Secretary of Commerce as the principal telecommunications policy adviser to the President, and Vice President. In this capacity, DoC/NTIA provides administrative support on the planning and implementation of the Administration's NII/GII initiative. DoC/NTIA efforts are focused on:

- The Telecommunications and Information Infrastructure Assistance Program (TIIAP), a competitive, merit-based program which provides matching grants to state and local governments, health care providers, schools and universities, libraries, community groups and other non-profit entities to access new telecommunications and information technologies. TIIAP, which is administered by DoC/NTIA, received requests for more than $560 million in 1994. Secretary Brown announced 92 TIIAP grants totalling $24.4 million in government funding in October 1994. The TIIAP projects will demonstrate how NII can be used to create a technology-literate and creative work force ready to compete successfully in the 21st century.

- The Information Infrastructure Task Force (IITF), formed by the White House and chaired by Secretary Brown, consists of

high-level representatives of the Federal agencies that play a major role in the development and application of information and telecommunications technologies. The IITF articulates and implements the Administration's vision for the NII. NTIA provides administrative support and staff assistance for much of the work of the task force.

- The U.S. Advisory Council on the NII (NIIAC), established by the President through Executive Order No. 12864, consists of thirty-seven members appointed by Secretary Brown to provide private and public sector consensus advice to the Secretary on the development of the NII. The Council members represent many different stakeholders in the NII, including industry, labor, academic, public interest groups, and state and local government. NTIA provides administrative support for the Council.

- The G-7 Telecommunications Ministerial in Brussels in February 1995 will advance the development of the GII as the foundation of the information society and provide an opportunity for private sector as well as governmental exchanges. The GII holds significant economic and social promise for all nations and, although the private sector will lead the development and implementation of the GII, such cooperation and collaboration among nations is essential. NTIA has the prime responsibility within the Department for the preparations for the G-7.

Telecommunications Legislation.

The Administration supports passage of telecommunications reform legislation that will open markets to competition while including safeguards as necessary to protect the public interest. Successful legislation should promote competition, provide open access, ensure regulatory flexibility and preserve and enhance universal service to ensure that all Americans have access to the benefits of the NII. NTIA expects to work closely with Congress during the next session to develop a bipartisan bill to accomplish these goals.

Telecommunications Research.

NTIA's Institute for Telecommunication Sciences (ITS) is the Nation's premier Federal telecommunications research facility. ITS is performing state-of-the-art telecommunications research and engineering to improve telecommunications system planning, design, and evaluation. Current efforts focus on personal communication services; broadband radio; and related wireless and wireline communication technologies. A key aspect of ITS agenda is centered on research and engineering studies to further applied knowledge of the radio frequency spectrum. The resulting

spectrum use concepts and models will lead to more efficient industry and Government use of the radio frequency spectrum.

Radio Frequency Spectrum Analysis.

NTIA manages the Federal government's use of the radio frequency spectrum. Program activities broadly address every aspect of radio frequency spectrum management, including authorizing government frequency assignments, providing in-depth technical engineering analyses of spectrum use to promote increased sharing of spectrum resources and spectrum efficiency, supporting domestic and international policy development and long-range planning, establishing plans and policies that ensure the efficient, effective and equitable use of the spectrum, and representing the U.S. government position at international conferences, technical study groups, and standards bodies.

THE PATENT AND TRADEMARK OFFICE

Administration of the Patent and Trademark Laws.

The PTO has been at the forefront of the Administration's efforts to improve U.S. competitiveness in the international marketplace by stimulating the technological capabilities that bear on economic growth. At the heart of technological-based economic growth are America's innovators. The PTO provides an invaluable link between America's innovators and a technology-based economy. The PTO serves America's inventors and entrepreneurs by providing them with the protection and encouragement they need to turn their inventive ideas into marketplace realities. The PTO accomplishes this by administering the laws relating to patents and trademarks, which includes issuing patents, registering trademarks and disseminating patent and trademark information to the public. Innovative activities appear to be at an all time high. This is evidenced by the record number of patent and trademark applications filed and the record number of patents issued this past fiscal year.

Dissemination of Technology to Stimulate Innovation.

At the root of innovation is information dissemination. The PTO promotes innovation by widely disseminating patent and trademark information throughout the world. Not only does the PTO publish patent and trademark information weekly, but it also supplies the public with patent and trademark information through its 78 depository libraries located throughout the country and its automated systems in its Public Search Rooms located in Arlington, VA.

The PTO also relies on the private sector to disseminate patent and trademark information. The PTO "wholesales" data on a

marginal cost basis in the form of our data base tapes to private sector firms. This allows private sector companies to provide value-added services to the public by enhancing and repackaging the data and making search systems available through commercial networks.

The PTO has made the full text and images of about 1,500 AIDS-related patents available to the public. This AIDS-related patents data base represent a huge leap in making patented technology available to the public. It not only spurs the research community to create methods of curing and controlling AIDS, but also demonstrates the potential of the use of patents as a tool for promoting technology and education.

New Examination Guidelines.

The PTO is taking aggressive steps to address the concerns of one of the most important patent user communities -- the biotechnology industry. One of the recent significant steps taken by the PTO is the proposal of new guidelines for examiners to follow when reviewing patent applications for compliance with the utility requirement of 35 U.S.C. § 101. The proposed guidelines should prevent the "catch-22" complained of by many biotechnology companies, whereby a company is required by the PTO to provide human clinical data to support therapeutic utility while at the same time that company is unable to raise funds to perform the trials that generate the clinical data because the status of the patent application is unclear. The proposed guidelines will also address several other problems identified by the biotechnology industry.

Future Patent Reforms.

The PTO will continue its efforts to improve domestic and international levels of intellectual property protection and promote industrial and technological progress in the United States. The PTO will work with Congress to implement legislative reforms that will make the patent and trademark systems work better and provide more effective rights. Such legislation would speed innovation by making technology, especially foreign technology, available to the public at an earlier date. In addition to Congressional initiatives to reform patent and trademark practices, the PTO, with assistance from the public through public hearings, will continue to review its operating procedures and change any procedures that prove to be burdensome, inefficient or outmoded. Doing so will enable the PTO to provide U.S. businesses with one of the most important competitive tools they need to compete in today's market -- adequate and effective intellectual property rights.

The Office of Air & Space Commercialization

Introduction.

The Office of Air & Space Commercialization (OASC) advises the Secretary and Deputy Secretary in the formulation and implementation of policies which foster the growth and international competitiveness of the U.S. commercial space sector, and which promote the commercial use of space by U.S. private industry.

Remote Sensing.

In March Deputy Secretary Barram, on behalf of the Administration, announced a major policy change in the treatment of commercial remote sensing imagery and systems. The U.S. Policy on Foreign Access to Remote Sensing Space Capabilities (PDD NSC-23) anticipates expanded sales of commercial images from space and a new market for the export of remote sensing systems themselves.

This policy represents a major milestone in the commercialization of space-based imagery and unleashes the potential of a critical 21st century information technology at a time when the international market for space-based imagery appears poised for significant expansion. It should open the way for U.S. aerospace firms to aggressively compete in a $400 million market worldwide, a market which could grow to more than $2 billion by the year 2000. The geographic information systems market (which is the market for images incorporating demographic or technical data with digital maps) could be in the range of $5 to $15 billion by the turn of the century.

The commercial remote sensing policy also aids the defense industry in its efforts to find new commercial applications for defense technologies. Moreover, the data produced by this technology will include environmental and geographic information that will greatly advance emergency management and rescue, disaster relief, mineral exploration, crop management, cartography, real estate and a variety of other commercial endeavors and become an important product to be delivered over this country's National Information Infrastructure.

OASC will continue to foster the U.S. technological lead in this area into the 21st century, encouraging the worldwide exploitation of 1-meter imagery by aiding in the implementation and refinement of this policy in the coming years. It will be responsible for representing private sector interests while considering national security and foreign policy concerns in interagency and intergovernmental policy discussions.

Space Launch Trade Agreements.

OASC, on behalf of the Department, has worked with the rest of the U.S. government and other nations to help increase the size of the world market for space launch without jeopardizing economic advantages that the United States has gained.

Launch-service trade agreements developed with the governments of Russia and China strive for an environment under which introduction of launch vehicles from economies in transition will cause minimal economic disruption. These agreements will allow U.S. launch service providers to compete fairly with foreign providers for international business, and aid the transition of formerly non-market economies to economies based on fair and even trade.

As we reach the turn of the century, OASC will be involved in the maintenance of the agreements already signed, as well as in negotiating possible new agreements with other non-market foreign launch providers. The office views these agreements as an integral part of the Administration's plan to develop low-cost, dual use, reliable access to space and foster fair competition in the international launch market.

National Space Launch Policy.

OASC has begun exploring new and innovative relationships between government and the private sector in the area of space launch.

A new Presidential policy on space transportation (U.S. National Space Transportation Policy, NSTC-4) recognizes the importance of private sector input into government space launch policies and activities. This policy reflects a paradigm shift toward supporting increased commercial activity in space, therefore encouraging growth in satellite manufacturing, launch services, and space applications, and reducing the cost of access to space.

In response to this policy, OASC organized a Government-Industry Roundtable of 25 CEO's from the launch, satellite manufacturing and satellite operating community. The intent of the meeting was to listen to private-sector concerns and suggestions for developing an overall strategy on how to help make this industry more internationally competitive.

As a result of this meeting, OASC and the Department of Transportation's Office of Commercial Space Transportation are developing a policy implementation plan that spells out specific means of promoting the international competitiveness of our space transportation sector. With industry, NASA, the Department of Defense, and the Congress, the two offices will examine the role of the private sector in the design, financing and development of U.S. next generation launch systems. They will also explore

innovative industry-government arrangements for new space transportation systems (Ex., risk sharing, tax incentives, equity participation).

Emerging Space Applications.

OASC is keeping an eye on the future of space by supporting the development of unique and innovative commercial activities in space. OASC's plans include investigating ways to remove impediments to a privately-financed, next generation commercial space-based production facility. The office is consulting with private Global Positioning System equipment manufacturers to examine the application of GPS technology to the National and Global Information Infrastructure and the every day utility of accurate, world-wide position information. OASC is also examining the role of satellites and wireless communication in the GII.

The CHAIRMAN. Thank you, Mr. Secretary. We, I am sure, will have some questions to follow up. At the moment, I would like to allow Mr. Brown to have an opportunity to make some opening statements.

Before doing that, our guests—and we appreciate so many of them have come this morning—some of our Members are having trouble seeing charts as a result of the standing room, and I would hope that we would try, as far as possible, to allow the Members access to the materials that the witnesses are bringing to us.

I would also ask at this point unanimous consent that all Members be permitted to submit remarks for the record to open the hearing.

[The prepared statement of Mr. Roemer follows:]

Opening Statement, Rep. Tim Roemer, Committee on Science, January 6, 1995

Mr. Chairman, it is an honor to once again serve on this Committee in the 104th Congress. In the past I have worked closely with Chairman Brown on the agenda of this panel, and I am pleased that on numerous occasions I had the opportunity to work with you as well in your capacity of Ranking Minority Member.

It is my sincere hope and expectation that we will continue our productive relationship, and your previous dedication to this Committee, its reputation and our ability to produce quality legislation bode well for our future under your leadership.

Today we will be looking at a snapshot of our sceince and technology future from the vantage point of the year 2015. It is important that we do so for a number of reasons. Obviously, we are entrusted with the stewardship of laying tracks for the future of science policy and technology development.

But there is an element to this responsibility that we must be much better at than in the past. It is relatively easy to speak of the possibilities of the next twenty years. But we must also realize that our potential is seriously tempered by our ability to pay for it.

We must decide now what is necessary for the future based not only on what our capabilities are, but we must also consider our abilities to afford such development.

There are many superior advances waiting in the wings, and we are charged with deciding which we must have and what we must live without.

If we are to build a space station, what other space projects must be left behind? If we decided to build the world's largest supercollider, when do we decide that the cost has become too high?

One of these decisions has been made, and it is my view that we cancelled the wrong project. But we have many such decisions to be made, and they must be made now.

I hope that this hearing will begin that process in earnest.

The CHAIRMAN. And with that, I would recognize my friend from California, Mr. Brown.

Mr. BROWN. Thank you, Mr. Chairman.

I will not interrupt the smooth flow of the witnesses with an extended statement, but I did wish to compliment you for, first, having the foresight to select the topic for this hearing, a 20-year look into the future. Obviously, you have piqued the interest of a lot of people here this morning. You have piqued my interest as long as the 20-year outlook doesn't include 20 more years of Republican control.

The CHAIRMAN. We are building a constituency here.

Mr. BROWN. I would point out that what you have done is in keeping with the committee's long tradition to look beyond the present to make sure a better life is laid for the next generation. The 20-year time horizon is appealing because 20 years ago this week, at the beginning of the 94th Congress, the Committee on Science and Astronautics, as it was at that time, was expanded into a full-fledged Committee on Science and Technology with legislative jurisdiction for the first time over energy, environmental and oversight jurisdiction over all civilian research and development. So we are now in a process of evaluating the fruits of that first 20 years and looking at the next 20 years, and I commend you very much.

I ask permission to put the rest of the my statement in the record.

[The prepared statement of Mr. Brown follows:]

Opening Remarks

Congressman George E. Brown, Jr.
Ranking Democratic Member
Committee on Science

Full Committee Science Policy Hearing
January 6, 1995

I wish to compliment Chairman Walker for choosing to begin the Committee on Science's hearing agenda for the 104th Congress with a twenty year look into the future for the major programs within our Committee's legislative jurisdiction. This is in keeping with our Committee's long tradition of looking beyond the present to making sure that the groundwork is being laid for a better life for the next generation of Americans. I find the 20 year time horizon especially appealing because 20 years ago this week, at the beginning of the 94th Congress, the Committee on Science and Astronautics was expanded into a full-fledged Committee on Science and Technology with legislative jurisdiction for a first time over energy, environmental, and aviation research and development and oversight jurisdiction over all civilian research and development. It is natural as we evaluate our successes and failures over these past two decades to think and begin planning ahead a similar length of time.

Sometimes we have been able to see the future surprisingly well. Almost 20 years have passed since our colleague Ray Thornton chaired his first insightful hearings on biotechnology which was then an idea rather than a major industry. Just a little later Congressman Jim Scheuer held hearings on using computer technology to cut back on the overhead in the health care system. I expect over the course of this year we will examine topics in transportation, in materials science, and in information technology which will affect our lives over the next twenty years just as much as biotechnology and computers have touched us over the past twenty.

A science historian, examining our past, could undoubtedly pick out a series of principles which underlie our efforts to improve quality of life in America through science and technology. While I am not a historian, I would like to share a partial list with you. We have shown a willingness to take risks and to adapt our thinking to new ideas. We have stood for fairness and equality of opportunity through merit review and our war on pork. We have been the Congressional champions of quality including total quality management. We have sought to make sure that the benefits of technology are just as available in rural America and the inner city as they are in the most affluent suburbs. We have protected the interests of small schools and small businesses. We have tried to make sure that regulations and standards are based on the best science available. We have worked to make sure U.S. industry reaps the primary benefit of our investments in the science and technology, that cooperative efforts with industry are industry-led, and that American workers have the skills to

win their fair share of high-paid jobs. We have recognized the unique U.S.'s unique responsibilities as a leader in science and technology.

Our witnesses today will be sharing with us their accomplishments in the past and their dreams of an exciting future. It is important to note that these accomplishments were rooted in a fundamental commitment by the Federal Government to promote and foster scientific research and development. The future will be no different. We are talking about science, not magic--we will need to maintain a firm Federal commitment to funding the scientific enterprise if we want to accomplish these dreams of the future. I remain concerned that the combination of a balanced budget constitutional amendment, increased defense spending and decreased Federal revenues will place an enormous strain on our ability to sustain a commitment to these discretionary programs.

I want to commend our witnesses in advance for their heroic efforts to streamline their agencies and to do more with less. I fear that we are at the point where we will simply begin doing less with less. Given this course of action, twenty years from now we see a less robust science program, a slower rate of economic growth, and our world leadership position will only be a nostalgic recollection. I hope that we can use these hearings today to begin a fundamental recommitment to our nation's research and development program.

As a Committee, we obviously bear a heavy responsibility and there are significant consequences to our actions, good and bad. Therefore, I hope we can listen with an open mind to today's witnesses and to others who will follow them in the coming months, that we will have the patience to seek out the best advice available before we act, and that we will have the courage to act as statesmen once we understand what we must do.

Mr. BROWN. I ask unanimous consent to include a statement signed by the corporate leaders of America, supporting the importance of a balanced R&D program, which would include, also, regulatory reform, tax reform and investment in research and development.

The CHAIRMAN. Without objection.

Mr. BROWN. Thank you very much.

[The information follows:]

Council on Competitiveness

MEMORANDUM

TO: Members, House Committee on Science

FROM: The Attached Signatories

SUBJECT: Attached Statement on R&D Policy in the 104th Congress

DATE: January 5, 1995

As leaders from industry, academia and labor, we want to make you aware of our views on R&D policy as you prepare for tomorrow's hearing on the future of America's science and technology programs. Representing companies and institutions that depend on research and development for their continued success, we support a federal R&D policy that includes three essential elements: regulatory reform, tax reform and investment in R&D. We look forward to working with you as the 104th Congress re-examines the nation's R&D policy. We hope the attached statement is of help to you at tomorrow's hearing.

1401 H Street, NW • Suite 650 • Washington, DC 20005
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STATEMENT ON R&D POLICY AND COMPETITIVENESS

As the 104th Congress begins its historic work, efforts to promote research and development (R&D) should be high on the agenda.

In fashioning R&D policy, the Congress should keep in mind three fundamental principles.

First, science and technology are key to the nation's economic growth. Economists attribute the unprecedented productivity growth of the United States during the post-World War II period to its strength in research and development -- a conclusion borne out by the continuing global competitiveness of such American industries as telecommunications, computers, financial services, pharmaceuticals, chemicals, textiles, aerospace and agriculture. No program to improve the standard of living and quality of life of the American people can succeed without ensuring the nation's continued leadership in science and technology.

Second, the government has a central role to play in ensuring that the United States maintains that leadership. This principle has long been a subject of bipartisan agreement. The federal government has contributed to the nation's success in science and technology in numerous ways since World War II. It has financed about half the nation's research, supporting work in universities, corporations and government laboratories. It has promoted science education, university facilities and advanced telecommunications, putting in place the

groundwork for a thriving R&D enterprise. And it has spearheaded work to accomplish national missions, such as exploring space, improving health and maintaining national security, that, in turn, have sparked industrial innovation and increased productivity.

Third, government, industry and academia must work together in an active partnership for science and technology to move forward. Merely continuing 50-year-old R&D policies will not be enough to succeed in an era of global competition. In recent years, Republican and Democratic administrations, working with the Congress, have begun to frame a joint R&D policy for the post-Cold War world based on this notion of cooperation. We need to build on that foundation.

To promote cooperation, government must help create a tax and regulatory environment in which R&D can flourish. The new Congress should ensure that tax laws help increase the availability of long-term, patient capital; that regulations stimulate rather than stifle the R&D efforts of industry and universities; and that intellectual property receives adequate protection.

Government must also see that its own R&D dollars are spent in a way that enhances the long-term competitiveness of the United States. At a time when both federal and corporate budgets are under stress, this is more important than ever. The new Congress should support programs that provide incentives for private partners to pool their R&D capital and expertise to invest in long-term and riskier projects.

The private sector must continue to do its part as well. Industry has begun to focus its R&D on improving manufacturing and market performance. Universities are revamping their curricula and research programs to improve the nation's productivity. These efforts must be sustained and strengthened.

The new willingness of government, industry and academia to work together has already born fruit. The 1994 Critical Technologies Update recently published by the Council on Competitiveness showed that the United States has begun to regain its edge in a wide range of technologies. But a Council survey also found that most American business, labor and academic leaders believe that the nation's greatest competitiveness challenges still lie ahead.

The need to respond to this continuing challenge -- some might say "threat" -- must guide Congressional action in the first 100 days, and beyond. No new agenda, no new program, no new policy will succeed over the long term if it undercuts the ability of the United States to innovate and compete. We urge the Congress to move swiftly to eliminate regulations that unnecessarily encumber R&D and investment in new technology; to enact tax reforms and incentives that stimulate private R&D; and to continue to support federal R&D investment that enhances the nation's competitiveness and encourages cooperation among the government, industry and academia. We stand ready to work with the Congress to develop a comprehensive R&D strategy that includes all three of these elements.

Signatories to Statement on R&D Policy and Competitiveness

Richard C. Notebaert
Chairman and Chief Executive Officer
Ameritech Corporation

Joel Marvil
Chairman and Chief Executive Officer
Ames Rubber Corporation

Ray Stata
Chairman of the Board and Chief Executive Officer
Analog Devices, Inc.

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President
Xilinx Inc.

As of January 5, 1995

Mr. OLVER. Mr. Chairman, I note that there are no copies of the charts which were a part of the testimony by the Secretary, and I hope that the Chairman will make certain that we all get copies of charts that would be used by the people who are testifying.

The CHAIRMAN. Mr. Secretary—

Secretary BROWN. They will be made available to all the Members of the committee.

The CHAIRMAN. Thank you, Mr. Secretary; and I thank the gentleman from Massachusetts. That is a useful addition.

We will proceed by asking Mr. Goldin from NASA to give his testimony.

STATEMENT OF HONORABLE DANIEL S. GOLDIN, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. GOLDIN. Thank you, Mr. Chairman. I would like to submit my formal statement for the record and summarize that statement.

The CHAIRMAN. Without objection.

Mr. GOLDIN. Mr. Chairman, the college class of 2015 is one year old today. They are just beginning to walk and they are just beginning to talk. They have lots of love and nurturing from their parents and grandparents, I might point out. What we are about today is talking about their future.

We could talk about all the things we have to do to survive today, but life is about the future and life is about the class of 2015. We want economic security for them. We want them to have abundant resources. We want them to have a clean environment. We would like them to have freedom through national security, through a strong, leading-edge technological base; and most of all, we want them to be inspired so they don't become couch potatoes and drop out of society. I am afraid that that is what is happening to our young people today.

What they don't need is a tax burden from wasteful spending, from spending that focuses on the jobs of today instead of creating the future of the jobs tomorrow.

During the last two years, under the guidance, leadership and vision of President Clinton, we have been revolutionizing NASA by working with the President and with Congress. We have cut the NASA budget by 30 percent, its projection in the five-year period. We have faster, better, cheaper experiments. They no longer take decades, they no longer cost billions of dollars and they no longer have piles of paper for scientists only. We have prioritized our tasks and we have downsized, but this is not enough. The American public wants more.

We have to speed up the pace of change, and we have got to revolutionize the management of NASA, not just the science; and we will need the help and support of this committee to make that happen next year, because this year and next year we set the future of the class of 2015.

The NASA of the future in 2015 will be much different than today. Instead of spending over half our budget on infrastructure and operations, we will privatize and commercialize. We will have objective contracting and we will convert that money to revolution-

ary R&D. There is not enough of revolutionary R&D in the NASA budget.

We are going to develop the tools for the future. We need computers that are one billion times faster than the computers we have today. We are going to need advanced decision-making machines so we don't have to have thousands of people on the ground operate our systems, so that they can be self-sufficient. We will need robots, we will need microelectronics and micromechanical systems of performance we can't even dream about today. We will have to have a fundamental understanding of micromolecular surgery and biotech and biomed. And most of all, we will stop with paper. We will put money on the table, ask contractors to bid, and we will build experimental craft in a few years to demonstrate the kind of things that we have to do.

We will enable but—we will enable America not just to open the space frontier, but we will enable America to provide the things our young people need. The data will be available not only to the scientist but the data will be available to the young people. Robots operated by children and high school students will be on the moon, part of the regular curriculum. Asteroid return samples will be evaluated by high school students and put onto the Internet, and we won't have to wait a year for scientists to come forward with their products.

We will understand the earth's environment, so 20 years from now the future decision-makers will make decisions based upon facts and not passion and emotion. The future of human space exploration will be set by the Space Station Alpha. This Space Station will allow us to understand how people could live and work in space safely and efficiently, how we could integrate robots with machines, how we could have new forms of power generation. It will lay the possibilities for future industrial parks and recreational parks in space.

We will have a new rocket. We cannot go on forever with the Space Shuttle. This rocket will be advanced technology. There are a bunch of people that are afraid of single-stage-to-orbit; we are not afraid at NASA.

We will have leapfrog technology. We will not have me-too activities like the rest of the world.

We will have much lower cost access to space. It will be much more reliable, and 20 years from now children will not have to crave the opportunity to go into space because we will open the space frontier for them.

We will answer the fundamental question we have been asking for 25 years after we shut down Apollo. Will we build a lunar base? Will we have a laboratory on an asteroid? Will we have an industrial park in space? Will we send astronauts to Mars to see if humans can live there? We will be ready to change history, Mr. Chairman.

In aeronautics we will have a fleet flying in which the American aircraft industry will have earned a quarter of a trillion dollars in sales. These planes will travel at 2.5 times the speed of sound. They will go from Los Angeles to Tokyo in just over four hours. They will be clean, quiet and economical; anyone could travel on

them. It won't be like the Concorde where you have to be filthy rich to travel. It will open up the Pacific Rim.

We will have experimental craft traveling at 25 times the speed of sound. We will open up the 5,000 airports of America. Right now, 90 percent of the flights go into 100 airports. With an advanced air traffic management system, with modern electronics and small, efficient planes, we will change transportation in this country.

These are risky, bold adventures. We can't be faint of heart. We have to have the courage to do this, but most of all we have to remember that this is for our children. We want to inspire them. We want to tell them you can take risks and you could fail. We at NASA will be on the cutting edge of this revolution.

Thank you very much.

[The prepared statement of Mr. Goldin follows:]

National Aeronautics and
Space Administration

Hold for Release Until
Presented by Witness

January 6, 1995

Committee on Science

House of Representatives

Statement by:
Daniel S. Goldin
Administrator

104th Congress

Statement of
Daniel S. Goldin
Administrator
National Aeronautics and Space Administration

before the
Committee on Science
House of Representatives

January 6, 1995

We've started a revolution at NASA. It's real. We have a road map for change. We've already begun.

We're downsizing. We cut our five-year budget projection by 30%. We're replacing big, expensive projects with smaller, more efficient ones. We're in the midst of a zero base review that puts everything on the table. No program is sacred. We're looking at everything NASA does.

We've stepped up to President Clinton's challenge of reinventing government. NASA has already reduced its roll by about 1500 employees, as we still have about 2,500 to go. We've chopped our Headquarters support contracts by roughly 25 percent, and our Centers had taken even deeper cuts.

The bottom line is that NASA is making fundamental changes. The result will be a NASA that does the right things, with the right number of people at the right cost. A NASA that is even more relevant to out ultimate customer: the American taxpayer.

There are three basic reasons America has a space and aeronautics program. And all of them have to do with relevance.

One, NASA helps give America's children economic security. We broaden the nation's economic base. That's an investment in their future. Two, we help give America's children national security. We help preserve America's leading edge in science and technology. And three, we enrich society. We make American's lives better.

Let me expand on that just a little. NASA's programs benefit and inspire all Americans, whether they're in Pennsylvania, South-Central Los Angeles, or the high plains states. Many things we take for granted today --medical imaging devices, ultra-reliable communications systems, even automatic teller machines--had their genesis in technology we developed to meet tough challenges in space.

But NASA's relevance is in more than just "spinoffs." The U.S. aviation industry has greatly benefitted from the high-risk technology work in our aeronautics program. Our satellite and aircraft imagery has helped Americans cope with natural disasters such as Hurricane Andrew, the Midwest floods and earthquakes in California.

One of the reasons we can do all this is our special role in science and technology. We're the bridge between the fundamental research done by universities, and the goods and services delivered by industry.

Our ability to be this bridge is strengthened by teamwork with other Agencies. We do some of this through the National Science and Technology Council. The Council was established by the President on November 23, 1993 to coordinate science, space and technology throughout the federal government. This coordination draws on what each Agency does best. It cuts redundancy and waste. And it helps government deliver more to the American people.

While the Administration is making changes to prepare for the future, I believe it is important that this Congress, at the same time it pursues a balanced budget amendment as a key element of the Contract with America, ensure that a very high priority is given to continued, stable investment in the Nation's civil research and development agenda. Balancing the budget by 2002 will involve an extraordinary degree of fiscal discipline. While working towards this goal, we must keep in mind that continued investment in R&D is a critical component of our economic security and the best means by which we can assure a prosperous future for America.

That's a little bit about where NASA is today. Now let me talk about the vision for NASA in the year 2015.

First, NASA itself will be very different. We'll be different in many, many ways, but let me just give you a few examples.

By the year 2015, the reinvention of NASA begun by this Administration will have produced a much more effective expenditure of resources. We'll devote much more of our resources to R&D to accomplish the real challenges in space and aeronautics, and the very bold endeavors such as revolutionary planetary missions, new launch vehicles and high-performance computers. We'll spend much less on operations and infrastructure. We'll put most of our resources into research and technology development and let industry do the rest.

We'll have a new management system, too. And we'll write objective, simple contracts. Contracts that say something like, "We'll pay X amount of dollars to the first company to return water samples from Mars."

We'll be developing the tools of the future. We'll need them. Right now, computer speeds are off by nine orders of magnitude for what we want to do. We'll need cutting-edge technologies to do our missions.

Which brings me to our basic mission. NASA is an investment in the future because we explore. We go out into the wilderness of space and peel away its secrets. And by the year 2015, we'll have some stunning new glimmers.

We'll have mapped the entire Solar System. We'll have gone past Pluto and out to the Oort cloud, where the building blocks of creation are hidden.

We'll take pictures of every planet around the 100 nearest stars at a resolution of 100 to 1,000 km.

We will have sent an armada of small spacecraft out into the universe. They'll cost tens of millions of dollars, not ten times that. They'll be light, too -- 50 to 100 kilograms each. And instead of needing thousands of people on the ground to support them, they'll be self-sufficient.

The data they send back will be available to everyone. In real time. People in America and around the world will be watching as we fly by Pluto and drill wells on Mars.

Robots on the Moon will be operated by children as part of their regular science classes. High school students will analyze samples and put their findings on the Internet.

This kind of data won't just belong to scientists anymore. It will belong to the world.

We'll better understand our own planet, too, thanks to Mission to Planet Earth and other programs. Working closely with other agencies, by the year 2015, we will understand the fate of the ozone hole, and the U.S. will have capabilities to provide global climate trends months in advance. Farmers will study satellite data to measure the health of crops and balance world food needs. The nations' of the world will be sharing environmental data through a global change data system.

And then there's the future of human exploration.

The international Space Station is the key. That's where we're going to learn what we need to know to go further into space. It's our stepping-stone into deep space.

But we won't allow the Station to outlive its usefulness. In fact, by 2015, the Space Station may have served its purpose. We may have learned how people can live and work in space for long periods of time. We may know what we need to know to send human beings to another planet.

We'll also have a new rocket by the year 2015. One that's more efficient and cheaper than the Shuttle. We'll have new power generation, robotic tools and many other 21st Century technologies.

And we'll know the answer to a question that's tantalized the world for the last 25 years. Where should we go next? We could build a lunar base on the Moon. Or an experimental laboratory on a near-Earth asteroid. We could build an industrial park in space. Or go to Mars and find out if people can live there. In other words, we'll be ready to change history.

I've talked a lot about the exciting possibilities in space. But I don't want to ignore our aeronautics program. It's vital to the U.S. aviation industry. And that industry is one of America's greatest strengths. In the year 2015, our research will be even more closely coupled with industry needs. We'll be more relevant to U.S. aviation. We will have gained back hundreds of thousands of jobs. And regained much of the 25% market share this country has lost in the last 25 years.

All of this -- in aeronautics and in space -- is within our grasp. We can do it. We're revolutionizing NASA to do it.

But we have to be willing to take some falls along the way. Some of the things I've talked about are risky. Bold ventures are. We will have failures. There will be losses. Pushing the edge of the envelope has never come with guarantees. Doing new things doesn't always work right the first time. We can't let that stop us. We can't be too fainthearted for the journey.

It will be worth it. We will deliver tremendous benefits to Americans.

We'll develop design tools that help industry cut development time for products and systems. We'll increase fuel efficiency. We will understand how people can live and work in space. We'll enrich the lives of the aging, the suffering and ill. We already have quite a track record with that.

And we will inspire America's children. In this age of fierce global competition, the U.S. ranks 13th in math and science. Our children need skills, and they need inspiration. They need to be excited about America's future and theirs.

NASA will play a pivotal role as America enters the next century. Twenty years from now, America's children could be inspired as never before. Inspired because they travel into space. Because they see and touch the sand and rock of distant planets. Because they're discovering. Because they're connected to the wonders of the universe. Because their parents' generation made an investment in their future.

Thank you.

The CHAIRMAN. Thank you, Mr. Goldin.

We will now hear from the Administrator of the Environmental Protection Agency, Carol Browner.

STATEMENT OF HON. CAROL M. BROWNER, ADMINISTRATOR, ENVIRONMENTAL PROTECTION AGENCY

Ms. BROWNER. Thank you for the opportunity to appear before you today. I would ask that my full statement be included in the record and will summarize my statement.

The CHAIRMAN. Without objection.

Ms. BROWNER. I also want to begin, Mr. Chairman, by thanking you particularly for your long-standing support of the science that we do at the Environmental Protection Agency. It has been a welcome support, and we look forward to continuing to working with you.

Charting the future of science is an important and challenging endeavor that will serve our Nation well both today and in the future. I think it is important, however, to look back for a moment.

Let us imagine what our country would be like today, what our neighborhoods would be like today, the health problems our children would face today if we had not taken all of the steps we have taken in the last 25 years to protect the health of the public, to protect the health of our environment. Imagine the Cuyahoga River in Ohio but don't imagine it today as the bustling center of tourism and local business, but rather 25 years ago when it burst into flames because of pollution.

Imagine our children in school today struggling with learning disabilities that could have been prevented except that we took the steps to ban lead in gasoline to protect our children.

Imagine cities where children, people with asthma, the elderly, the most vulnerable in our population, are not able to go outside because the air irritates their lungs and leaves them gasping for breath.

Mr. Chairman, I am proud to tell you that these situations I have described no longer exist in this country, and that is because of our Nation's investment in scientifically based public health and environmental protections. We not only made wise investments in science, but we are using those results in common-sense, cost-effective ways to protect our neighborhoods, our families and our environment. Without scientific research and its application, today would be a very different day—one with fewer problems avoided, one with less-healthy children, one with fewer thriving local economies. We would be spending far more on handling crises and doing far less to protect our children's future.

To those who would suggest that we have no need for additional research in science, who would suggest that our Nation's environmental problems have been solved, my answer is absolutely not. We must maintain the progress we have made in protecting public health in the environment. We must build on that progress with common-sense, cost-effective steps that will reduce and prevent problems in the future.

Already we are seeing scientific data that signal our future, that signal the problems that lie in our path, problems we can work to address through research today or handle as expensive crises to-

morrow. With these warning signals clearly in front of us and the unmistakable positive results of strong environmental protection behind us, this is no time to diminish our Nation's scientific explorations or the strong environmental protections to which the research has led us.

This Administration is committed to furthering sound science in our efforts to protect the health of the public, the health of our environment. Sound science is essential to effective decision-making.

I am absolutely convinced about the importance of science as the basis for our environmental future, which is why we have already undertaken a number of steps at EPA to keep our scientific progress sound and productive as we use it to make the difficult but fundamentally important decisions about how to protect our environment and our people. At EPA we have already established a new policy that requires impartial scientific peer review of all major science products that form the basis of EPA's regulatory actions. We have simplified the way in which we develop regulations, incorporating science earlier and more effectively in the process. We have streamlined the structure of our research and development operation from 15 labs to three labs and two national centers. We have improved the way we conduct and communicate the results of risk assessments and we have doubled funding for research grants to be conducted by scientists outside of EPA so that we can benefit from what has made this country so great, the work of the best and brightest scientists this country has to offer.

Mr. Chairman, I would like to take a moment to discuss one of the tools that is a very important part of our scientific program, one that has been the subject of much debate. That is risk assessment. Risk assessment is a particularly important tool in making decisions about how to best reduce risks to public health, safety, the environment. It is a tool that is used across the Federal Government. It is a tool that we already use at EPA in almost every major regulatory decision.

This Administration would support risk assessment legislation that allows fair, effective and affordable use of the tool. We believe that risk assessment should provide both the decision-makers and the public, the people who will be affected by our decisions, with a meaningful understanding of the risks that will be addressed by our actions as well as an understanding of the assumptions and uncertainties inherent in that assessment.

The science used in risk assessments should undergo peer review and be communicated clearly to the public. We have and will continue to take steps to assure that our risk assessments meet these goals.

We would caution however, Mr. Chairman, against legislative proposals such as some of those, of the risk assessment provisions in the Contract With America which could freeze scientific progress and unnecessarily delay actions necessary to protect the health of our children and our neighborhoods.

We also must be mindful that science, particularly risk assessment, cannot be subjected to a one-size-fits-all approach. The resources we direct toward a particular risk assessment should be consistent with the significance of the action. Only then can we guarantee the American people that our decisions are based on

both economic and environmental sense. We would look forward to working with all Members of Congress to ensure that these goals are met.

I need this committee's help to strengthen science at EPA. I remain unequivocally committed to the continued improvement of risk assessment as a tool to help us set priorities. I stand firmly behind the use of impartial peer review to help ensure the quality of the science that EPA uses for its decisions, and I am absolutely for an increase in openness, accessibility and free interchange of scientific information.

I believe, Mr. Chairman, that you and this committee, working together with the agencies and departments appearing here today, have the ability to give the American people a future full of strong protections for the environment and public health, strong protections that are based on sound science, that we can look back and say that we made the right decisions, that we made the tough decisions for our health, our economy, our neighborhoods, our future. We look forward to working with you on common-sense ways to achieve this vision of the future.

[The prepared statement of Ms. Browner follows:]

STATEMENT OF
CAROL M. BROWNER
ADMINISTRATOR
U.S. ENVIRONMENTAL PROTECTION AGENCY
BEFORE THE
COMMITTEE ON SCIENCE
HOUSE OF REPRESENTATIVES

JANUARY 6, 1995

"How Can Today's Science Prepare Us For The Future of Environmental Protection?"

Thank you, Mr. Chairman and members of the Committee, for the opportunity to testify today at your first hearing as Chairman of the Committee on Science. I appreciate the chance to tell the Committee about EPA's long-range plans and the importance of science to the future of environmental protection. This is a critical time for strengthening science and research within EPA, and I want to talk with you today about some of the changes we are making to enhance and improve our science, research, and risk assessment programs.

At EPA, the role of science is very specific: to provide the scientific foundation for achieving EPA's vision of a world in which healthy and economically secure people live -- and are sustained by -- a healthy environment.

Given this broad perspective on the role of science at EPA, I want to discuss three points here today: (1) the need for a new generation of science; (2) our long-term vision for EPA; and (3) the first steps in our commitment to change our science base.

But first, let me discuss the context for these changes and for our science goals; and give you some examples of what we are currently doing within this context to achieve our environmental vision.

Reducing the Cost of Environmental Protection

All of us are committed to protecting public health and our air, land, and water. At EPA, we want to implement these commitments in the most cost-effective way possible. But to do this, we must move beyond a "one-size-fits-all" regulatory approach towards a more common sense approach -- an approach that uses flexibility, creativity, and innovation in reaching these goals.

Because I truly believe that economic prosperity and environmental protection go hand in hand, one of my goals at EPA has been to work in partnership with industry and state and local

governments to develop more cost-effective ways to reduce pollution. To this end, we are working on a number of fronts, all of which require a strong science base:

- Developing **non-regulatory solutions** that will achieve environmental goals, such as our voluntary programs -- the Green Lights and 33/50 programs;
- Exploring **market-based incentives**;
- **Fostering private sector development** of innovative, more cost-effective technologies; and
- **Promoting pollution prevention** in all of our regulatory and non-regulatory programs, through research and outreach, as well as programs like *Design for the Environment*, where we work with specific industries to help reduce emissions.

In addition, we are using the **Environmental Technology Initiative (ETI)** and the Administration's broader Technology for a Sustainable Future initiative as a springboard to promote the development and use of more cost-effective environmental technologies, mostly by the private sector. EPA has an important facilitating role: (1) adapting our policies, and our regulatory and compliance framework, to promote innovation; (2) verifying cost and effectiveness of innovative technologies to accelerate market penetration; (3) catalyzing partnerships among industry, and between industry and government, to focus on our most pressing problems; and (4) accelerating the diffusion and transfer of innovative technologies from developers to users, both at home and abroad. The initial 1995 ETI request brought over 1500 proposals that bear on one or more of these focus areas. In the true spirit of partnership, these proposals would leverage over $1 billion in non-ETI resources.

EPA has also developed an exciting new program: the **Common Sense Initiative**. In six pilot industries, EPA will work with industry leaders, state and local officials, and environmentalists to help find ways to make environmental protection work "cleaner, cheaper, and smarter."

The Common Sense Initiative is a fundamentally different vision of environmental policy. The current U.S. regulatory system addresses air, water, and land separately, frequently shifting and shuffling pollution without preventing it. As a result, we end up with too little environmental protection at too great a cost. Through this initiative, EPA will bring together federal, state and local government representatives, environmental leaders and industry executives to examine the full range of environmental requirements impacting six pilot industries. These six teams will look for opportunities to change complicated and inconsistent environmental regulations into comprehensive strategies for environmental protection. The initiative reflects our commitment to setting strong environmental standards, while encouraging common sense, innovation, and flexibility in how they are met. The goal: a cleaner environment at less cost.

It is critical that all of these programs fit within the framework of science.

America's Challenge: A New Generation of Science

In the past twenty years, we have solved some of our most obvious environmental problems -- we no longer have rivers catching on fire; our skies are cleaner. But much remains to be done. 70 million Americans -- one in four -- still live in areas where the air does not meet federal air quality standards; forty percent of our rivers and lakes are not suitable for fishing or swimming; thousands of people fell ill in Milwaukee in 1993 from contaminated drinking water.

Despite our successes, our past approach to developing national environmental policy will not achieve a similar level of success in the future. The nation now faces environmental challenges that the past approaches cannot resolve -- challenges that are related to less obvious, but more complex and diffuse environmental problems, such as nonpoint source air and water pollution; regional problems, such as the contamination of large parts of the Florida Everglades with mercury; and global-scale problems, such as stratospheric ozone depletion. At the same time, the scientific challenges are compounded by comparable challenges in the economics and management of proposed solutions.

Meeting these challenges requires a more integrated, more focused national environmental policy. Good environmental policy must blend many ingredients -- economics and social and legal issues, for example -- but the role of science in forging this policy is critical. Science can be our guide as we confront the complex environmental challenges of the future. To answer the multitude of questions that will arise tomorrow, we need a new generation of environmental science. This is one of EPA's goals for the year 2015 -- to develop the science base to help resolve these complex issues.

National Environmental Strategy: We at EPA realize that we alone cannot identify emerging issues and generate the knowledge that is needed to solve local, regional, and global environmental problems. To be effective, EPA must work collaboratively with other federal agencies that have responsibilities for protecting and managing the environment. We must, together with these other federal agencies, develop a coherent national research and science agenda for the environment, one that will organize activities and set priorities across the federal government.

For these reasons, EPA is a very active participant in the Committee for Environment and Natural Resources (CENR), established under the auspices of the President's Science and Technology Council (NSTC) to coordinate all federal environment and natural resources science and research activities and to improve the links between science and policy.

EPA developed its FY 1996 research budget in accordance with the goals and priorities developed through the CENR. CENR provides the opportunity to shape environmental science and research priorities across the federal government and to better coordinate environmental

research, which will help us ensure that the research conducted by other federal agencies complements EPA's research and helps us meet our policy goals.

EPA's Vision

I share your concerns about the need for long-range planning to meet the scientific and technical challenges of the next twenty years. To this end, I have started three inter-related activities to better focus our future environmental science needs: (1) the Environmental Futures Study; and (2) the Environmental Goals Project; and the (3) EPA Laboratory Study. Let me briefly discuss each of these activities.

Futures Study: EPA, and U.S. society, is often "coming from behind" in environmental protection, reacting to a crisis situation rather than anticipating future problems. To help our scientists and decision-makers plan for the future better, I asked EPA's Science Advisory Board, in the Spring of 1993, to:

- Examine scientifically sound approaches for anticipating environmental problems that might emerge in the next five to thirty years; and
- Apply the most promising of these approaches to generate a first-cut at what those problems might be.

The environmental futures project is an attempt to identify "over the horizon" problems that will likely confront us down the road. The SAB has been looking at existing trends, examining developing issues, and exploring possible activities, and has consulted with a diverse group of experts from academia, industry, and public and private groups. The SAB explored a variety of forecasting mechanisms and developed a thoughtful list of conditions that could emerge by the year 2015 and pose significant concerns for human health and the environment.

The Board will release its final report, *Beyond the Horizon: Using Forecasting to Protect the Environmental Future* later this month. It will contain specific suggestions on how EPA can systematically prepare itself to anticipate the future. We will provide you with a copy of this report as soon as it is available – it will become an important tool in our continued planning for the future. Their first recommendation is obvious, but particularly relevant to this discussion of the future of environmental science: "As much attention should be given to avoiding future environmental problems as to controlling current ones."

Environmental Goals Project: The Environmental Futures Project attempts to develop analytical methods to predict emerging problems; the Environmental Goals Project defines where we are headed with our current knowledge. As part of the Goals project – to better understand where environmental protection is heading – I have held a series of meetings across the country to talk about our country's environmental goals. The Environmental Goals project is an attempt to interact with a broad cross-section of the American public in order to reach consensus on a set of goals that the country wants to achieve in the area of environmental

protection. These meetings have been extremely valuable — and the results have become a part of the broad goals I have established for the coming years:

- *Keeping people healthy* by providing clean air, safe workplaces, and a safe food and drinking water supply. Examples include reducing childhood exposure to lead and reducing the use of hazardous agricultural chemicals.

- *Sustaining natural systems* by ensuring that human activities are compatible with natural processes, and that diverse natural systems are able to support economic development for years to come.

- *Preventing pollution* before environmental problems occur by producing and consuming in ways that will not create burdens for the future.

Science Vision: EPA Laboratory Study: Last year, I commissioned a study of EPA's science and research capabilities. I will discuss these recommendations in more detail later in this testimony. We are now implementing the recommendations from this study, which I think will fundamentally reorient EPA's science and research agenda and future directions.

To effectively tackle the enormous environmental challenges ahead of us, I believe EPA needs a new generation of environmental science. EPA's new science efforts will need to:

- Provide the scientific leadership to catalyze the environmental science efforts of other federal agencies;

- Engage the very best scientists in the country in its programs, through partnerships with universities and industry;

- Focus on developing and nurturing the environmental scientists and engineers of the future;

- Promote the development and use of cost-effective technologies, particularly those that reduce pollution at the source;

- Develop more compete information and data about the impacts of pollution on humans and on ecosystems; and

- Characterize and communicate environmental risks more effectively.

This new generation of science will provide the underpinnings for the important environmental challenges facing us. Let me tell you how I plan to make these goals and this science vision a reality.

EPA's Commitment to Change: Our First Steps

As you can see, EPA has set a new and challenging vision for itself and the environment over the coming years. To achieve these objectives, EPA must move beyond reacting to today's environmental problems to working with our partners to anticipate and prevent pollution. We must transition from piecemeal solutions to a more integrated environmental response that utilizes the best available science. And in all our activities, EPA must ensure equal protection for all and effective stewardship of resources.

In the past two years, I have taken a series of actions that are moving us towards these goals and this vision. I want to talk about two issues that both Congress and EPA are concerned with:

- Quality science for quality decisions; and
- Risk assessment to focus on the most important problems.

Quality Science for Quality Decisions: Using the best available science in EPA decisions

In its 1993 report: Research to Protect, Restore, and Manage the Environment, the National Research Council stated that "Environmental policy, both legislative and regulatory, is often produced without benefit of the best science available. Scientists often pursue research programs without adequate consideration for the policy-makers who must make policy in the face of inadequate information and understanding." The NRC cited an issue that EPA has been wrestling with for its entire existence: how do we focus EPA's science on areas that help policy-makers make decisions, ensure high-quality science, and incorporate an understanding of good science into our policy-making process?

In the past year, I have begun a variety of activities that address this issue, and that, I hope, will go a long way toward mitigating these concerns by:

- **Establishing an Agency-wide Science Policy Council** to address science policy issues that go beyond regional or program office boundaries;
- **Reforming EPA's rulemaking process** to better incorporate science and data into the Agency's rulemakings; and
- **Expanding scientific partnerships** with the outside academic and scientific community.

As an example of partnerships, EPA is working with scientists from the federal government, the private sector, states, and the Canadian government to develop a North American research plan for tropospheric ozone. This plan, and the research that evolves out of this plan, will help solve the problems highlighted by the National Academy of Sciences report on ozone. Another excellent example is EPA's dioxin reassessment, where we have coordinated

with outside scientists to ensure that the most-up-to-date information and analysis is used in this reassessment.

In this testimony, I want to emphasize our realignment of EPA's science and research capabilities, because I think it is fundamental to the future of science at EPA.

Realignment of EPA's Research Program

EPA is now in the middle of a significant restructuring which I think will pave the way to fundamentally reorienting EPA's science and research agenda and future directions. This effort began with a reexamination of the structure and focus of our research program, as part of an ongoing effort to improve the quality of EPA science and to expand the range, efficiency, and effectiveness of the approaches and tools available to mitigate and solve our nation's environmental problems. As part of this effort, EPA last year concluded a study of all of EPA's research and technical support laboratories.

The **EPA Laboratory Study** proposed major new directions for EPA's science and research programs. One important issue that emerged from this study is the understanding that EPA research, development, and technical services must continue to promote risk assessment and risk management as the principle that drives priority setting. As a result, we have changed the way in which we will decide what science and research to do: we will give priority to research that will have the greatest impact on reducing the uncertainty in risk assessments, and on facilitating risk management.

We are now taking the steps recommended in the study and changing many aspects of our research program, primarily conducted within our Office of Research and Development (ORD). Three integrated actions have emerged from EPA's Laboratory Study:

1. **Relevant Research:** First, EPA intends to change its research program so that 50% of EPA's research dollars go to support long-term research, so that we can better identify environmental problems, and get early warning of tomorrow's problems. The remaining 50% of the Agency's research dollars will be used to vigorously support the applied research and implementation requirements of the regulatory programs and regions. This reallocation responds to the recognition that research to meet immediate needs must be balanced against a stable, fundamental research program designed to provide solutions for the environmental problems of the future.

2. **Scientific Excellence:** Second, because effective environmental policies rely on sound science, EPA is committed to providing the best possible products in the areas of research, development, and technical support. We have embarked on a series of initiatives designed to enhance the quality of our science. Many of these initiatives involve strengthening our partnerships and relationships with the academic community. They include:

- **Enhanced peer review:** One of the most important items on my agenda is to enhance EPA's use of peer review. Impartial peer review is critical to the success of our science. In June I established a new peer review policy that affects every office within EPA. Peer review will be expanded and strengthened throughout EPA, so that all major scientific documents will undergo peer review. This will ensure that our decisions are based on the best science possible. We are also revising our processes for deciding what we do and how we do it, as well as how we review our laboratories. We are formally working with the National Science Foundation (NSF) and the National Research Council (NRC) on these peer review processes.

- **An expanded grants program:** To take advantage of the expertise and creativity of the academic and non-governmental research community, EPA is expanding, over the next three years, its program for extramural research grants. The funding level for the program will be an estimated $44 million in fiscal year 1995 (up from $22 million in 1994) and is expected to grow further in subsequent years with the goal of achieving an annual funding level of $100 million. EPA is working in partnership with the NSF to jointly solicit and evaluate proposals under this program. It is anticipated that this partnership with the NSF will lead to joint funding for innovative research in environmental science and engineering, and environmentally related social science research, such as contingent valuation and risk communication.

- **Graduate fellowship program:** EPA is establishing a nationally competitive, peer-reviewed graduate fellowship program in academic disciplines relevant to the environment. Both the public and the private sector will need a steady stream of well-trained environmental specialists if our society is to meet the environmental challenges of the future. The goal is to fund at least 100 fellowships in 1995, 200 in 1996, and 300 in 1997. These fellowships will defray most of the costs associated with advanced study leading to the masters or doctoral degree.

3. Restructuring and Streamlining: Third, EPA is consolidating its 12 national research laboratories into 3 National Laboratories and 2 National Centers, to better address the risk assessment/risk management paradigm that is fundamental to the Agency's mission. They are:

- National Health and Environmental Effects Research Laboratory
- National Exposure Research Laboratory
- National Risk Management Laboratory
- National Center for Environmental Assessment
- National Center for Environmental Research.

EPA is decentralizing research management and administration, and streamlining headquarters' operations. This reorganization better aligns laboratory missions, providing organization of EPA's research on a multi-media, multi-stressor basis involving both human and ecological risks.

These changes are far-reaching, integrated actions that will provide EPA and the nation with better science, better decisions, and better environmental protection.

Risk Assessment: Focusing on the most important problems

As always, it is important to ensure that our scarce resources are focused on the most important environmental problems. Risk assessment is one of the tools we use to set these priorities.

How do we define risk assessment? Risk assessment is the process used to characterize and quantify the potential adverse human health effects – and ecological effects – of environmental contamination. In risk assessment, information about the toxicity of a contaminant is combined with information on human exposure to that contaminant to produce an estimate of risk. Risk assessment is key to determining which environmental problems pose the greatest risks to human health and the environment, helping policy makers better direct policies and regulations to achieve the greatest risk reduction. As you can see from our reorganization plans, risk assessment is a critical principle for EPA's research and science program.

Risk assessment has always been the focus of much debate: What is it? How is it used? How do we communicate risks to the public? More than a decade into the debate, the controversy over risk assessment shows no signs of lessening, and has spilled over into proposed legislation. Congress introduced more than 10 bills in the last legislative session that either focus on risk assessment or have a significant section devoted to risk assessment.

I'd like to talk with you about how we at EPA view risk assessment and what we are currently doing to improve the process.

Throughout the past decade, EPA and the other regulatory agencies have established risk assessment as a systematic way to consider and weigh environ- mental data, showing its strengths and limitations. Risk assessment has come to provide a consistent methodology, however contentious, for evaluating qualitative and quantitative risks. Risk assessment is now used at all levels of the federal government – to set priorities, to develop environmental standards, and to develop appropriate risk reduction activities.

EPA has been a world leader in the science of risk assessment, and the use of risk assessment to make decisions. We at EPA view risk assessment as one of the most valuable tools in our efforts to protect public health and the environment. It is a tool that will play a strategic part in shaping environmental policy decisions for years to come.

But risk assessment is a relatively new and rapidly developing science, and our methods must evolve as our understanding grows. Risk assessment is by nature a dynamic, complex and ever-evolving process. New information and new perspectives should — and will — continue to shape the risk assessment process.
As public comments on guidelines and other policy issues involving risk assessment are received and evaluated, we expect to make continual changes in this evolutionary process. Strengthening the risk assessment process is integral to achieving EPA's strategic goals.

EPA has been an active participant in the ongoing debate about risk assessment. We are very aware of the issues and problems surrounding risk assessment, and are taking action to deal with these problems. We now have a series of actions underway including:

- **Revising Cancer Guidelines,** to take into account the most recent scientific thinking on cancer.
- **Developing Clearer Risk Characterization Guidelines,** to give EPA managers and the public a clearer picture of the nature of the information used in the risk assessment, the data gaps, the uncertainties involved, and the assumptions that were made. The guidelines are designed to carefully separate science decisions from policy.
- **Refocusing our Risk Assessment Research,** to work towards reducing the uncertainties in risk assessment and improving our tools for managing environmental problems.
- **Expanding EPA's Framework for Ecological Risk Assessment,** to improve our ability to address risks to ecosystems in a consistent way.
- **Improving IRIS,** the Integrated Risk Information System, to enhance the peer review of IRIS data.
- **Revising Regulatory Impact Guidelines** to incorporate the latest economic methodologies, which will improve our ability to communicate the costs and benefits of Agency regulatory actions.
- **Directing greater attention to noncancer health risks,** including developmental and reproductive toxicity, neurotoxicity, and other effects.

We believe that sound science is essential to effective decision-making. Risk assessment is a particularly important tool in making decisions that would reduce risks to health, safety, and the environment. It is a tool we use in most of our major regulatory decisions. In making major regulatory decisions, the Administration supports risk assessment legislation that assures fair, effective and affordable use of risk assessment.

Further, we believe that risk assessment should provide the decision-maker and the affected public with a meaningful understanding of the risks addressed and the assumptions and uncertainties inherent in the assessment. The science used in risk assessments should undergo appropriate peer review and be communicated clearly to the public. We have taken and will continue to take steps to assure our risk assessments meet these goals.

While we can support legislation that meets these goals, we caution against legislative proposals that could freeze science and unnecessarily delay actions needed to protect our citizens. In addition, the resources directed to a particular assessment should be commensurate with the significance of the action. And all our decisions should be based on common sense.

We look forward to continuing to work with the Congress on this issue over the coming legislative session.

Working Together: The Federal Government's Role in Science

As you can see, we at EPA are changing the way we work to keep pace with the times. I have told you about some of our new initiatives, and I realize that many more opportunities exist to increase partnerships, promote common sense, and develop our science capabilities. One of these opportunities is within the federal government, which has a critical role in fostering the science necessary to protect our environment. Through the CENR, the entire federal science and research structure is working together to achieve our ambitious goals.

The other opportunity is working together with Congress to ensure that economic prosperity and environmental protection go hand in hand. Joining together is not a matter of choice, it is a necessity. We all breathe the same air, drink the same water, and work and play in the same environment. If we join together, we can take the common-sense steps we need to take – and be proud to pass along a safe, clean world to our children and our children's children. We look forward to working with you and your staff to accomplish this.

Thank you.

The CHAIRMAN. Thank you very much, Ms. Browner, for your statement.

We will now move to Dr. Lane.

STATEMENT OF THE HONORABLE NEAL F. LANE, DIRECTOR, NATIONAL SCIENCE FOUNDATION

Mr. LANE. Thank you, Mr. Chairman, Congressman Brown, Members of the committee. I very much appreciate the opportunity to participate in today's hearing.

I would like to ask permission that my extended remarks be included in the record.

The CHAIRMAN. Without objection.

Mr. LANE. A hearing on the future, with the specific focus on the role that science and technology will play in the future, seems a particularly appropriate way to begin a new Congress and a new year. I am especially pleased to be participating in this hearing with my colleagues from the other agencies because we work closely together through the National Science and Technology Council to coordinate our efforts as part of the administration's science and technology team.

The National Science Foundation's role in the support of science and fundamental engineering research and education spans the past 45 years. We are the only national institution that is mandated to support research across the full range of scientific disciplines. In carrying out that mission, which will be as important in 20 years as it is now, NSF helps to support comprehensively the underlying research enterprise that the various federal agencies and U.S. industry draw upon to achieve their specific objectives.

Science—and I will include fundamental engineering as science—is not about the future. It is the future. And while we surely cannot forecast where and when discoveries will be made, research in science provides a process and a perspective which historically has produced new knowledge that has proven to be vital and diversely useful to sustaining this Nation on a successful path.

As America's comprehensive national institution established to promote and enhance all fields of science, NSF has a pivotal role to play here. Our recently completed strategic plan, entitled NSF in a Changing World, sets three long-range goals for science which I will abbreviate as world leadership, knowledge and service to society, and excellence in education at all levels. I would like to briefly highlight each of these.

World leadership in scientific research does not naively assume that only America has top-notch scientists. That is not correct that we are the only Nation to have top-notch scientists. Rather, it is a goal to articulate the need for our Nation to be on the cutting edge, the frontier, in all important fields.

We cannot expect to win all the Nobel Prizes, but we should aspire always to be a major player in all fields of science. Striving to attain this goal will help protect the broadest range of options for our economic and national security.

Scientific knowledge in service to society, our second goal, recognizes that science is integral to life on the planet today, a world very much predicated on and powered by science and technology. Thus, we cannot afford to hold science separate and autonomous

from our everyday lives. Our Nation, indeed every society, has real needs and real problems, and science must toil in those trenches as a partner in finding solutions.

Progress toward these first two goals, world leadership and knowledge in service to society, presents us with the third goal, excellence in education at all levels for a technologically literate society. Science education in our schools should strive to make students, the children, the grandchildren Dan Goldin talked about, not only science conversant but also science participatory. If there is any surefire way to integrate science into society, it is to build science confidence in young people through their own experimentation, their own analysis, their own questioning, their own mistakes. Over the years and in a bipartisan fashion this committee has been instrumental in providing strong support for our science and engineering programs at the pre-college, undergraduate and graduate levels.

With these three overarching goals to guide our progress and perspective, we at the National Science Foundation are confident that holding firmly to the notion that science is the future will move us steadfastly into the 21st century and beyond.

As an institution, NSF represents about 3 percent of all the Federal R&D investments. However, we support almost half of the Nation's nonmedical research conducted at our academic institutions, and we provide 30 percent of the Federal support for math and science education.

Recently, the leadership role of the United States in science and technology has been put to new tests. Over the last five years, commencing with the fall of the Berlin Wall, America has been adjusting to a new world position and defining a new national direction. This hearing and the work of the Committee on Science is obviously an important part of that ongoing process. These next few years will be a period of transition in which our Nation will have the opportunity to build on our past successes in science and technology while embracing new goals and perspectives.

Taxpayer-funded research focusing on answers to fundamental questions that defy our ability to predict outcomes, of which NSF is the primary overall supporter, is not mutually exclusive of research that has a conscious relationship to the Nation's priorities and societal needs.

The eminent scholar, Donald Stokes, in his work in progress entitled, Pasteur's Quadrant, writes: "The annals of research so often record scientific advances simultaneously driven by the quest for both understanding and use that we are increasingly led to ask how it came to be so widely believed that these goals are inevitably in tension and that the categories of basic and applied science are radically separated."

The title of the work comes from the example of the French scientist Pasteur who, as we all know, was influenced by public health and commercial goals throughout his stellar career in microbiology.

One might say Pasteur engaged in use-inspired research, to use Donald Stokes' term. This does not mean that we should adopt a narrowly directed agenda of targeted research—that would be a mistake—but rather a program of science and engineering research

that clearly is in and for the national interest in its most comprehensive interpretation.

To my mind, the question is not where is the dividing line between science and technology or between basic and applied research but rather how do we take better advantage of this interrelationship which is very real and very substantial in order for the Nation to reap the greatest benefits from its investment in science and technology. This is the question which all of us—the Federal R&D agencies, the Congress, this committee and the public we serve—must address and answer.

Let me conclude by noting that if you were to ask me to speculate on where the search for the big, unanswered questions in science and engineering will take us in the next 20 years it would not be false modesty if I said I haven't the slightest idea. The historical record shows that those who have made such predictions in the past—scientists and scholars of high acclaim, names familiar to all of us—have been notoriously wrong—proud but wrong.

On the other hand, I am confident that a process genuinely rooted in the quest for new knowledge, while cognizant of its integral role in society, will bring us predictable and solid success.

Mr. Chairman, NSF appreciates the strong support you, Congressman Brown and the other Members of the committee have given us over the years. I look forward to the continuation of a very close working relationship with the committee as we plan together to ensure the best possible return to the Nation on its investment in NSF.

Thank you.

[The prepared statement of Mr. Lane follows:]

Testimony of

Dr. Neal F. Lane

Director, National Science Foundation

before the

Committee on Science

House of Representatives

January 6, 1994

Mr. Chairman, Congressman Brown, and Members of the Committee, thank you for the opportunity to participate in today's hearing. A hearing on the future, with a specific focus on the role that science and technology will play in that future, seems a particularly appropriate way to begin a new Congress and the new year. I am especially pleased to be participating in this hearing with my colleagues from the other agencies because we all work together as part of the Administration's science and technology team.

Clues to the future can often be found in an examination of the past, and my testimony this morning will begin with a brief summary of the evolution of NSF's role in the support of research and education over the past 45 years. It is important to appreciate that in carrying out this role, NSF helps support the underlying research enterprise that the various Federal agencies and industry draw upon to accomplish their objectives. NSF represents only about 3 percent of all Federal R&D expenditures, however we support almost half (48%) of the nation's non-medical basic research conducted at academic institutions and we provide 30 percent of the Federal support for math and science education.

In my testimony this morning I will provide a brief historical overview of the Foundation followed by some remarks on how changes in recent years have affected NSF and how our strategic planning process is preparing us for the challenges we face.

NSF in a Changing World

The mission and purpose of NSF is succinctly stated in the opening of the National Science Foundation Act of 1950, which states that the agency is established:

> To promote the progress of science; to advance the national health, prosperity and welfare; to secure the national defense . . . .

Over the years NSF has supported these goals by seeking out and supporting research based on the best ideas from the most qualified people -- as judged by experts in their respective fields -- and by nurturing the nation's future scientific and technical leaders. The majority of our research support has gone, and continues to go, to individual investigators and small groups of researchers. Approximately 60 percent of the total research support is designated for individual investigators or small group research projects.

But other methods for supporting research and education activities have also been developed, including the establishment of national research facilities such as astronomical observatories, particle accelerators, and supercomputing centers. We have also supported research through center-based activities such as Industry-University Cooperative Research Centers, Engineering Research Centers, Science and Technology Centers, Materials Research Laboratories, Long-Term Ecological Research Centers, and Minority Research Centers of Excellence. Our center-based research provides a setting for cross-disciplinary activities as well as an opportunity for students to broaden their research horizons and industrial partners to interact with first-rate academic researchers. Industrial participation comes in many ways -- monetary support, advisory activities, and help in identifying problems that cannot be solved without a better understanding of fundamental scientific and engineering relationships. The centralized mode of support is strictly reserved for those activities that cannot be carried out efficiently by independent investigators or small groups.

Through our Experimental Program to Stimulate Competitive Research (EPSCOR), the Foundation has helped develop the academic research capabilities of states which, historically, have been less competitive than most others in obtaining federal research funding.

Similarly, we have introduced new approaches to improving mathematics, science, engineering, and technology education, most recently by supporting systemic reform at the state, city, and regional level rather than relying on piecemeal changes within a single subject matter or individual school.

As part of the National Performance Review activities, NSF is also providing government-wide leadership in the application of technology to the receipt and processing of proposals and the management of Federal research and education awards. We have centralized geographically scattered activities into a "smart" facility

to reduce operating costs and we have implemented a program of continuous improvement of our operations.

These innovative collective approaches for supporting research and education have come about because the research and education communities have identified challenging and important scientific opportunities that simply go beyond what can be tackled by an individual investigator working alone. The growth in support of more integrated research and education activities in such "strategic" areas as high performance computing and communications, advanced manufacturing technology, global change and environmental research, advanced materials and processing, biotechnology, and science, mathematics, engineering, and technology education also reflects the benefits of multidisciplinary approaches to problems.

Let me give you an example. Developing an understanding of the principles underlying the performance of very large scale computers draws on expertise in areas as diverse as mathematics, electronics, engineering, human factors, cognitive science, and materials, to name just a few. To go a step further, using supercomputers to help understand complex scientific problems such as weather forecasting or the design and synthesis of new materials brings together scientists and engineers from even more disparate backgrounds.

An illustration of the convergence of knowledge that is needed to understand a complex phenomenon occurred in a rapid change in 1982, when the temperature of the sea surface along the coast of Peru rose 4 degrees Centigrade (7° F) in 24 hours, an astounding rate of increase for tropical Pacific waters. Over the next six months, regions of Peru that are normally dry received up to 3 meters (10 feet) of rain. The Peruvian fishery, one of world's richest, nearly collapsed. At the same time Eastern Australia suffered the worst drought in its history and French Polynesia, an area that had not seen a typhoon in 75 years, was hit six times in five months.

Global losses attributed to this change in global weather patterns were in excess of $8 billion and 1500 deaths. Efforts to understand and possibly predict this weather cycle involved oceanographers, atmospheric scientists, climate modelers, and software specialists, among others. Research supported by four Federal agencies -- NSF, NOAA, NASA and ONR -- has already produced models useful for predictions in forecasting oscillations in the El Nino. The results of this ongoing work are being used for economic and environmental planning in Peru, Ecuador, Brazil, Australia, India, China, and Ethiopia.

NSF has developed a framework that stimulates researchers to consider their work in a larger context, both as a way of encouraging the types of interdisciplinary efforts that

occur on the frontiers of science, and as a way of supporting research in areas that relate to national concerns.

Many of these approaches to supporting research and education might seem exotic to those who first conceptualized NSF. Nevertheless, I think that our current efforts would meet with their strong approval. They would certainly recognize that advances in research and education open new possibilities for innovative programs. They would also appreciate that unless we encourage researchers to stretch themselves and take risks, we will miss the major discoveries that revolutionize science. And I am confident that they would agree that along with a commitment to excellence, NSF must continue to provide the leadership necessary to promote the advancement of science to meet the nation's most critical needs in an ever changing world.

Recently the leadership role of the U.S. in science and technology has been put to new tests. Over the last five years, commencing with the fall of the Berlin Wall, America has been adjusting to a new world position and defining a new national direction. This hearing and the work of this Committee is an important part of this process. These next few years are a period of transition in which our nation has the opportunity to build on past successes in science and technology while embracing new goals and perspectives.

NSF support of research focuses almost exclusively on answers to fundamental questions that defy our ability to predict the outcomes. Still, it is important to recognize that taxpayer-funded fundamental research can and should have a conscious relationship to the nation's priorities and societal needs. This does not mean a narrowly directed agenda of targeted research, but rather, a program of fundamental science and engineering that clearly is in and for the national interest, in its most comprehensive interpretation. I believe that in order to assess the quality and effectiveness of this program, we must actively involve the research community in helping to set national scientific goals and identifying special areas of opportunity.

It was fifty years ago that Vannevar Bush set a course for American science and engineering in his small but powerful treatise, *Science, the Endless Frontier*. That fifty year period took us through the Cold War and has given us a solid foundation for providing a better quality of life in the post-Cold War era. The promise of NSF that Bush foresaw is being fulfilled today.

Goals for the Future

Science, as we all know, is not about the future -- it is the future. It is the quest for new understandings and new ways of doing things. It solves old problems and sometimes uncovers new ones. While we cannot forecast where and when discoveries will be

made, research in science and engineering provides a process and a perspective which historically has produced new knowledge that has proven to be vital and diversely useful for the future

NSF will continue to play a pivotal role to play here. Our recently completed strategic plan, entitled *NSF in a Changing World*, sets the following long-range goals:

> First, enable the U.S. to uphold a position of world leadership in all aspects of science, mathematics, and engineering;
>
> Second, promote the discovery, integration, dissemination, and employment of new knowledge in service to society; and
>
> Third, achieve excellence in U.S. science, mathematics, engineering, and technology education at all levels.

The first goal, upholding a position of world leadership in areas of research across the board, is a capstone goal, one that is necessary for giving the nation the broadest range of options in determining our economic future and providing for our national security and the well-being of all Americans.

The second goal notes the science community's responsibility for disseminating the results of research, for showing how it is connected to both ordinary and extraordinary concerns and how it can be put to use for the public good.

Progress toward these first two goals -- world leadership and knowledge in service to society -- requires a technologically literate public. In addition, I believe the need for excellence in science, mathematics, engineering and technology education at every level will only grow in the coming years. Science education in our schools should strive to make students not only science conversant but also science participatory. If there is any sure-fire way to integrate science into society it is to build science confidence in young people through their own experimentation, analysis, and questioning. Over the years, and in a bipartisan fashion, this Committee has been instrumental in providing strong support for our science and engineering education programs at the precollege, undergraduate, and graduate levels.

Core Strategies and Values

The Foundation's strategic plan also provides a set of core strategies that will guide our progress toward these goals. These strategies reaffirm the Foundation's traditional support of merit reviewed, investigator initiated proposals. But they also recognize that

in the future, as in the past, NSF will develop, change, and invent new methods to keep up with the needs of the research community and the country.

The first strategy is the development of intellectual capital. This has been a core mission and core value of the NSF since its inception. From my own point of view as a working scientist for many years, I believe that NSF has done this job exceptionally well. Our goal at the Foundation is to do it even better. In particular, we can improve our efforts by broadening the base to include more women, minorities, and individuals with disabilities as active participants in science, engineering, and technology fields. We can also encourage universities and colleges to consider changes in their curricula and degree programs to better prepare their graduates for a wide range of career options.

The second strategy is to strengthen the physical infrastructure. Although we have an outstanding research infrastructure in many respects, there is a continual need to modernize facilities and instruments, to set priorities for the next generation of instruments, and to optimize the use of our existing infrastructure. Out of researchers' efforts to carry out more accurate measurements under unusual conditions often come new technologies important to industry and other applications.

The third strategy is to integrate research and education. Too often we fail to capitalize on the natural connections between the process of education and that of discovery, just as we fail to recognize the complex interdependence of fundamental science and its uses and applications.

The fourth strategy for implementing our goals is to promote partnerships. NSF has been effective in developing successful partnerships over the years. These have included collaborative efforts with the academic community, with industry, with elementary and secondary schools, with state and local governments, and perhaps most significantly given this hearing, with other Federal agencies. For example, NSF has signed a Memorandum of Understanding with the National Institute for Standards and Technology to coordinate research in the areas of materials, chemical science and engineering, and manufacturing. Each partner brings its unique expertise to this arrangement – NSF has strong ties with the academic research community and a tradition of supporting discovery. NIST has connections with the private sector and experience in responding to the needs of industry.

Our approach to these partnerships has emphasized shared investments, shared risks, and shared benefits. Our partnerships have also taught us about the complex relationships that exist among research, education, technology, industry, and other government programs. They have allowed us to coordinate our programs and share our strengths. We have formal agreements to coordinate and collaborate with virtually

every agency involved in research activities. In this regard, I would point to the National Science and Technology Council as a place where agencies can work together to establish research priorities, foster partnerships, develop and facilitate cooperation, and avoid duplication.

One of the most important lessons we have learned comes from NSF's partnerships with industry. These have taught us that industry recognizes the need to create new knowledge, even in esoteric areas, and that the new knowledge almost always stimulates new ways of thinking about existing technology. For example, research on the fundamental nature of fluids passing through small openings involves a host of problems related to pressure, viscosity, flow rates, particle deflection, and dispersal patterns. The industrial partner at Engineering Research Center at Purdue University initially most interested in this line of research was involved in spray painting. But perhaps the biggest benefactor the research was Cummins, a company that makes diesel engines, because the same fundamental principles are important for fuel injection systems. Not only was Cummins able to use this research to improve their own engines, they used it to develop fuel injection systems that overseas engine manufacturers use. This is the kind of interaction that can result when you make the kinds of people-to-people connections that our programs encourage.

The eminent scholar, Donald Stokes, in his work-in-progress entitled *Pasteur's Quadrant*, writes "The annals of research so often record scientific advances simultaneously driven by the quest for both understanding and use, that we are increasingly led to ask how it came to be so widely believed that these goals are inevitably in tension and that the categories of basic and applied science are radically separated." The title of Stokes' work comes from the example of the French scientist Pasteur, who, as we all know, was influenced by public health and commercial goals throughout his stellar career in microbiology.
To my mind, the question is not, where the dividing lines are between science and technology, or between basic and applied research, but rather how do we take better advantage of the interrelationships in order for the nation to reap the full benefits of its integrated investment in science and technology? This is a question that all of us – the Federal R&D agencies, Congress, this Committee, and the public we serve must address.

Related to this theme of integration is the idea that the research community has often lived an independent and somewhat isolated existence within American society. This position has historical roots that are no longer either applicable or valuable to our current goals. Informed debate on public policy, high value jobs, competition in global markets, and the education of current and future generations require that science and engineering become a more integral part of our national fabric. And the research community needs to participate in this debate.

Conclusion

Let me just conclude by noting that if you were to ask me to speculate on where fundamental research in science and engineering might take us in twenty years, I would not be engaging in false modesty in saying: I really can't imagine. But at the same time I do have complete confidence that wherever research takes us in the coming decades we will look back at the investments that we are making today and see them as well worth every sacrifice they may have required.

The future that Vannevar Bush could have imagined at the close of World War II probably did not include personal computers, recombinant DNA, the Internet or decades of national policy being driven by the Cold War. Yet his vision has served us well because he recognized the value of government support of a healthy science and engineering research and education enterprise. In our efforts to keep pace with a changing world NSF has identified strategies to sustain Bush's vision into the next century. I am confident that by developing our intellectual capital and physical infrastructure, integrating research and education, and stressing the concept of partnerships, NSF will continue to play a significant role in helping meet the nation's needs into the future.

Mr. Chairman, NSF appreciates the strong support that you, Congressman Brown and other members of the Committee have provided us over the years. We have also grown increasingly aware of the need to develop better procedures to set priorities and evaluate our programs in ways that inspire the continued confidence of the Committee, the Congress, and the public. In this regard, NSF is continuing with a planning process that will help us to set realistic goals and measure our progress toward meeting those goals. I look forward to continuing to work closely with the Science Committee to ensure that we get the best possible return to the nation for its investment in NSF.

Thank you for the opportunity to participate in this hearing and I will be happy to answer any questions you or your colleagues may have.

The CHAIRMAN. Thank you, Dr. Lane.

We will go to Dr. Gibbons. He is the one who has the large overview of all of this.

We appreciate your being with us and look forward to your testimony, Dr. Gibbons.

STATEMENT OF THE HONORABLE JACK GIBBONS, DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY

Mr. GIBBONS. Thank you, Mr. Chairman, Mr. Brown and Members of the committee. I want to thank you for this opportunity to be with you this morning to present our vision across the panel of how our Nation's future hinges on sound investments in science and technology, and I have submitted my more extensive remarks for the record.

The CHAIRMAN. Without objection, they will be included in total, and we would appreciate your summarizing. Thank you.

Mr. GIBBONS. Most things this country values, I would posit—things like long-term economic growth, good jobs, high-quality health care, environmental protection, access to information, top-notch educational and worker training and a strong national defense to name but a few—depend on sustaining our world leadership in science and technology. I think that is a thing we can agree on but need to remember as we proceed.

The administration's science and technology initiatives that we have touched on this morning are based on a recognition that science on the one hand and technology on the other are linked in a multitude of ways, interconnected, tied together, each building constantly on the gains of the other domain.

This is a kind of a recognition that has only come about in the last decade. It is certainly true that all technological advance ultimately depends on fundamental science and the highly trained people that have been educated at our colleges and universities, but old distinctions made between so-called basic and so-called applied science no longer really make sense in our modern laboratories. The blending of discovery and application occurs across virtually all science and engineering.

The fundamental point here is that basic science, applied science, technology, though different in approach and in motivation and scale, are profoundly interdependent and would be separated at our peril. We have made the Federal science and technology enterprise a principal target of our effort to reinvent government, to make government more efficient and make it more responsive to its investors, the citizens.

Part of this, the President just a year ago created what I call a virtual agency, the National Science and Technology Council, to provide the kind of wisdom and set priorities and coordinate the implementation of science and technology policies and programs across the executive branch. I refer to this in my text but will not dwell on it further at this point.

We realized in doing that that the most important and cost-effective change that we might make in the way government conducts its science and technology business is to forge new cooperative links between the public and private sectors. Private businesses are the principal actors in converting technology to goods and services,

to profits and jobs, and have supported much of the research needed to develop products.

But the government also has indispensable roles to play in advancing technology. I will mention three: first, in ensuring a strong base of fundamental science, a tradition that began at least as early as Benjamin Franklin; second, providing a business environment that encourages innovation and investment through public policies; and, third, investing in research that is critical to the economic and social needs of the Nation but yet cannot attract adequate private support on its own.

The government partnership then fosters technology advance that otherwise might not be made, as Secretary Brown mentioned a bit ago, or it might be made in other countries with most of the benefit flowing in that direction.

Experience teaches us that the payoff in government investments in science and technology, if they are judiciously made, can be enormous. For example, we got much more than we expected from investments we made 20 years ago in biomedical research. Not only have we made great strides in the fight against disease and government funding of molecular biology and advanced instrumentation, without that much anticipation, also spawned an industry that is not only an $8 billion industry today but has expanded well beyond the biomedical and pharmaceutical fields far faster and further than I think anyone would have predicted even a decade ago.

The bottom line is that many economic studies have shown that Federal funds invested in science and technology brings on the average of 50 percent rate of return on our investment. I wish I could get that on my investments. I might add, Mr. Chairman, I am not sure I can think of another Federal investment that has that kind of yield, but I may be corrected.

You know from your record, Mr. Chairman, that you support science and technology and that you and the committee recognize the vital role that they play in the future of our Nation, our economic, our environmental and our national security future.

We very much appreciate your leadership in scheduling this hearing today to address this important topic, and we are very pleased to share your enthusiasm and the enthusiasm of the committee in taking on the challenge of seeking ways to strengthen our country's science and technology enterprise. That challenge, reinventing the way we do business to improve the benefits to the American taxpayer, is what the administration has been working on for nearly two years now.

Each of those agencies that you have heard from today and others as well, working both individually and as a team through the Science and Technology Council, have been reviewing and reinventing the Federal Government's role in support of our Nation's science and technology goals, and each has a record of achievement. We are pleased at the prospect of working with you and this committee in this historic effort, and you will find our agency leaders to be more than ready partners in this enterprise with you.

But in looking at the Contract With America, along with the fiscal year 1994 and 1995 Republican budget and other proposals for paying for the Contract, I must confess we do have some concern.

The administration shares clearly the commitment to reduce budget deficits and the inefficiencies in government. We have worked with I think some considerable success in bringing the budget deficit down, to cut government employment and in spending.

In the area of science and technology we have been playing what has been called a zero sum game for two years. That is, reoptimizing within an envelope of a constant number of dollars not even corrected for inflation. But we have taken great care in the process not to sacrifice our investments in the future; that is, in the well-being of our children and grandchildren in the process.

We have committed ourselves to sustained support of science and technology even in the face of extremely vigorous downward pressures on our assets. But science and technology is the seed corn, and we have to resist the temptation to eat that seed corn rather than to plant and nourish it.

Our initial interpretation of the proposals to fund the Contract With America raises concern that we might not be able to develop and disseminate the educational technologies that our children will need to compete in the global-knowledge-based economy, that we might not be able to invest in research that could ensure this Nation's continued preeminence in industries that are dependent on biotechnology or information and communications technologies, and that in fact as we and—as we move toward the end of this century this Nation might find itself in a wholesale, even devastating retreat from the investments on which our future depends, investments in science and technology.

So we will stand and fight with you in resisting such a retreat because it cuts to the core of our guiding premise that government must invest in our children's future in ways that promise the highest payoff.

We are a Nation of explorers. We need science and technology to nourish our national soul as well as our economic well-being. The administration intends to work with Congress to achieve these goals, Mr. Chairman, including long-term economic growth and efficient and responsive government and world leadership in science, engineering and mathematics.

Nothing could be closer to the heart of that future than the activities that this committee oversees. So we are particularly grateful and applaud your decision to hold this early hearing this morning, Mr. Chairman, and we very much look forward to working with you in this common enterprise.

[The prepared statement of Mr. Gibbons follows:]

Statement of
The Honorable John H. Gibbons, Director
Office of Science and Technology Policy

before the

Committee on Science
U.S. House of Representatives

January 6, 1995

Mr. Chairman, Members of the Committee, on behalf of the Clinton/Gore Administration, I thank you for this opportunity to present our vision of the future in science and technology. We wholeheartedly agree with you that the advancement of science and technology is a vital national goal which is absolutely essential for the future well being of our people and our Nation. And we believe government has a key role to play in working with industry and academia to achieve that goal.

As Peter Drucker has noted, "Long range planning does not deal with future decisions, but with the future of present decisions." So to start off the new dialogue between the Administration and Congress on present decisions about science and technology and their impacts on our Nation's future, I would like to focus on five things today:

- First, elucidate the goals -- from economic growth, to environmental protection, to national security -- of the Administration's science and technology policies;
- Second, highlight a few of the many spectacular results from past Federal investments in science and technology;
- Third, describe a few of the Administration's current science and technology initiatives and the benefits we anticipate they may provide in the coming years;
- Fourth, summarize how the Administration has reorganized Federal science and technology policy making to improve the links between government and the private sector and to maximize the return on Federal investments in research and development; and
- Fifth, discuss the inextricable links between science and technology.

GOALS FOR INVESTMENT IN SCIENCE AND TECHNOLOGY

As enunciated by the President in his first month in office, our science and technology policies and programs are directed toward three basic goals:

- -- Long-term economic growth that creates jobs and protects the environment;
- -- Making government more efficient and more responsive;
- -- World leadership in basic science, mathematics, and engineering.

Government is an essential actor in making sure science and technology help us reach our goals. Many of the benefits science and technology confer are in areas that are either outside the market or imperfectly subject to market forces -- such things as a strong national defense, first-class education and training, improved environmental quality, and fundamental scientific research. In these areas, a strong government presence in R&D investments is essential.

A government role is also vital in promoting technologies that are critical to economic growth, the creation of good jobs, and meeting the common needs of the nation, but cannot attract adequate private investment. In our partnerships with business for pre-commercial technology development, our cardinal rule is to use government funds only where they are essential and where the payoff to society as a whole is large. We invest government funds, on a cost-shared basis, where private sector investment is not adequate to the job because of unacceptably high technical risks, prohibitive cost, long payback horizons, or where the returns cannot be captured by the investing firm but spill out to competitors, other firms, or society at large.

Experience teaches us that the likelihood is that the payoff on government investments in science and technology, if judicially made, will be enormous. It is our steadfast belief that thoughtful federal spending on science and technology is simply good economic policy. Many economic studies have shown that federal money invested in science and technology brings, on average, a 50 percent rate of return to U.S. society.

ANTICIPATING THE RESULTS OF S&T INVESTMENTS

The record of the past half-century clearly shows a high average rate of return on public and private investments in science and technology. Of course, we can only make educated guesses about which investments will catalyze revolutionary developments in science and technology, and we must expect some failures. One of my early mentors, Alvin Weinberg, always said "Never make a prediction until you're very old; otherwise you might live to see it not come true." But if the past is any predictor, our expectations for an excellent return on our investments are not misplaced.

Had you convened a hearing like today's in January 1975, you might, for instance, have received testimony concerning the Administration's belief that emerging computer and telecommunications technologies would soon change the conduct of warfare; that continued funding of molecular biology would yield revolutionary advances in medical diagnosis and treatments; that progress on environmental pollution required major additional Federal research attention; or that technology could both quiet the noise and cut fuel consumption in airplanes. Decisions made at that time to invest taxpayer dollars in those areas turned out to be wise, for predictable as well as for unforeseen reasons.

- Public investments in fundamental research and development on information technologies did, in fact, revolutionize the conduct of warfare -- both the

weaponry deployed and the tools used to prevent or to prepare for war. Just as importantly, those investments changed the nature of commerce, indeed the nature of everyday life in this country. Early investments in ARPANet, the first national computer network, have brought us to the 25th anniversary of the Internet, a prototype of the Global Information Infrastructure. When it started out, ARPANet could transmit only 56,000 bits of data per second. Today, networks using technology several generations more advanced routinely transmit 45 million bits a second -- almost a thousand times faster. The Federal government provided a relatively small catalyst (a few tens of millions of dollars annually) that has been matched more than a hundred times over by private-sector investment in the Internet. Today, dozens of companies are investing millions of dollars and competing to provide Internet connections and new services to the tens of millions of Internet users around the world.

- Public investments in biomedical research have, as we expected 20 years ago, improved our understanding of the root causes of many diseases, leading to better preventive and treatment techniques. What we could not predict, but benefit from nonetheless, is the multi-faceted biotechnology industry that did not exist 20 years ago. Biomedical research spawned this industry that already accounts for 100,000 jobs and $8 billion in annual sales. We owe incredible advances in agriculture and in chemical and pharmaceuticals processing, as well as our ability to capture billion dollar markets in health care and other industries, to fundamental research in molecular biology and development of advanced instrumentation funded by the U.S. government.

- Investments in environmental research and development have improved air quality, moved us toward our goal of "fishable, swimmable" waters, and, as science often does, revealed unanticipated impacts of human life on the natural systems that support us. Twenty years ago, for instance, we determined a need to understand the impacts of emissions of anthropogenic chlorine, bromine, and fluorine on stratospheric ozone. Today we know unequivocally that the ozone layer is being depleted because of human activities. This knowledge has led to international agreements that limit the production and use of ozone-depleting chemicals. At the same time, advances in technology have resulted in cost-effective substitutes that do not degrade the ozone layer. Because of the research and early detection of stratospheric ozone depletion, technological response has enabled us to largely avert a major global health problem while still providing the benefits of air conditioning, refrigeration, and other necessities and amenities that once depended on ozone-destroying chemicals.

- Twenty years ago, civilian jet airliners were powered by fuel-guzzling turbojet engines that polluted the environment and disturbed people living near airports and under airline flight paths. Today, thanks to NASA research in

combustion, turbomachinery, lubrication, aerodynamics, acoustics, and materials and structures, those airliners are 50 percent quieter, 25 percent more fuel efficient, and emit less than half the atmospheric pollutants. Many NASA-developed technologies have been incorporated directly into the current commercial turbofan engines, helping U.S. manufacturers attain world leadership in technology and market share.

One could reasonably say that we got even more than we bargained for from the government's S&T investments of 20 years ago. They were strategic, meaning they were thoughtfully directed toward goals such as national security, high quality health care, and environmental quality. And, in hindsight, they were more than fully successful.

ADMINISTRATION INVESTMENTS IN THE FUTURE

I am confident our successors in governance in 2015 will be able to say the same about many current S&T investments – if, that is, they receive adequate financial support, both public and private. The Administration's science and technology investments are focused on six priority areas:

- A healthy, educated citizenry;
- Job creation and economic growth;
- World leadership in science, mathematics and engineering;
- Improved environmental quality;
- Harnessing information technology;
- Enhanced national security.

Today I would like to describe a few of the initiatives we believe will ensure long term economic growth, a broader knowledge base to support that growth, and a better quality of life for Americans.

- Technology for Economic Growth. The Administration has made a major commitment to work with the private sector on the development and deployment of advanced civilian industrial technologies, both here and abroad. Environmental technologies -- technologies that enable delivery of goods and services with less environmental pollution and technologies that trap pollutants or clean up pollution -- receive special emphasis in our investments. They will allow us to pursue our dual goals of economic development and environmental protection because we will be producing higher value goods and services with less energy, less waste, and less environmental harm.

  During the next twenty years, U.S. industries can significantly expand their share of what is presently a $300-billion global industry in environmental technologies. The potential public and private returns on investments in environmental technologies are tremendous.

This vision of economic growth combined with protection of the environment is not unfounded fantasy. Let me give a couple of examples. Over the past 15 years, the Intel Corporation (at their Portland, Oregon, plant) has more than doubled its production of semiconductors with no increase in emissions, and no new investments in pollution emissions control technologies. Instead, they have redesigned their entire production process to make higher quality chips with less environmental impact.

Also over the past 15 years, research into more efficient wind turbines and expanding markets have reduced the cost of wind-generated electricity by a factor of eight (from over $.40/kilowatt-hour to less than $.06/kilowatt-hour) and made the U.S. the leader in global wind energy production. These changes are indicative of what can happen within a time span of twenty years and give us a sense of what is possible as we look forward to the year 2015.

Alan Kay at Apple Computer was right when he said, "The best way to predict the future is to make it happen." For this reason, it is necessary for us to create strategic alliances with industry, to set long-term goals, to stimulate innovation, and to make sure our industries move significantly beyond their global competitors. We are doing this, for example, with the Clean Car Initiative and our work with the U.S. construction industry.

The Partnership for a New Generation of Vehicles, also known as the Clean Car Initiative, is one of our premiere ventures into cooperative civilian industrial technology development. In it, we are tackling a technological challenge as tough as putting a man on the moon -- that is, to develop within 10 years a car with 3 times the efficiency of today's automobiles with no sacrifice in cost, comfort, or safety. If the project succeeds, the payoff to the public will be huge in terms of less dependence on foreign oil and lower emissions of greenhouse gases. The project also holds the promise of an extremely attractive car for world markets in the 21st century and a thriving U.S. auto industry to produce them. The government (in this case, a consortium of Federal agencies) and industry (the Big 3 automakers and many suppliers of materials and equipment) are working closely together here to break highly challenging technological bottlenecks where the benefits are as much societal as commercial.

In our Building and Construction Initiative, our goal is to develop better construction technologies to improve the competitive performance of the U.S. industry, raise the life cycle performance of buildings, and protect public safety and the environment. The initiative responds to a high level of industry interest and combines government and industry goals. Construction is one of the nation's largest industries, with employment of 6 million and a total yearly value of close to $800 billion, yet U.S. building technology lags behind that of foreign countries and the incidence of injury in construction work is among the highest of all industries. We are determined, in full cooperation with industry, to enable, by 2003, the following future:

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- **Better constructed facilities**, meaning: a 50 percent reduction in delivery time; a 50 percent reduction in operation, maintenance, and energy costs; a 30 percent improvement in productivity and comfort; 50 percent fewer occupant-related injuries and illnesses; 50 percent less waste and pollution; and 50 percent more durability and flexibility.
- **Improved health and safety of construction workers**, meaning a 50 percent reduction in construction work injuries and illnesses.

This initiative is dedicated to removing nontechnical barriers to innovation, as well as putting greater emphasis on research and development and aligning government programs appropriately with industry needs.

- Investing in Fundamental Knowledge. America's future demands investment in expanding our knowledge base, in other words, in our people, institutions, and ideas. Science is an essential part of that investment – an endless and sustainable resource with extraordinary dividends. The nation's investment in world leadership in science, engineering, and mathematics has yielded a scientific enterprise without peer, whether measured in terms of discoveries, citations, awards and prizes, advanced education, or contributions to industrial and informational innovation. Our scientific strength is a treasure this Administration intends to sustain and build on for the future.

  We have pledged (as described in Science in the National Interest) to:
  - maintain leadership across the frontiers of scientific knowledge;
  - enhance connections between fundamental research and national goals, such as economic prosperity, national security, health, and environmental responsibility;
  - stimulate partnerships that promote investments in fundamental science and engineering and effective use of physical, human, and financial resources;
  - produce the finest scientists and engineers for the twenty-first century; and
  - raise scientific and technological literacy of all Americans.

  Broad investment in basic research is essential to our national defense strategy. A strong domestic science base supporting a robust national security S&T program is critical to preserving the technological superiority that characterizes our military advantage. The Administration's strategy is to apply resources broadly at the basic research level and make further investment decisions as emerging technologies reveal the most effective payoff areas. Through these investments in fundamental science, we can continue our science and technology advances, position ourselves to take advantage of maturing technologies, and minimize our vulnerability to surprise.

  We have given particular emphasis in the first two years of this Administration to a human resources development strategy aimed at producing the cadre of experts necessary for the scientific enterprise of the future; for research and development; for applied fields and industries; and for competing in a global marketplace. We are reevaluating the breadth and nature of graduate training – recognizing that we are not

training our scientists merely to work in laboratories and universities. We are projecting the workforce needs of our future economy and developing methods for fostering the basic skills necessary for all workers.

I cannot predict the science success stories of 2015. But our strong investment program for basic research sets the stage for the equivalent of:

- Fiber optics -- which were a germ of an idea in 1966 but now carry most U.S. long-distance telecommunications;
- The Hubble Space Telescope -- which has opened our eyes to distant galaxies in the same way the early space program opened our eyes to the wonders of our small planet and solar system;
- Global positioning system -- a confluence of basic research in physics, software, communications, and high-speed electronics first tapped for military purposes and now rapidly expanding into commercial markets for navigation and air safety and monitoring Earth's large scale ecosystems;
- Severe weather prediction -- which has emerged from the integration of space platforms, large computing power, and continued atmospheric science research.

I am sure we will see equally impressive and revolutionary developments in the coming years -- provided we maintain our strong commitment to basic research. My confidence stems, at least in part, from the fact that the process of good science inherently contains a healthy degree of skepticism and willingness to weigh new evidence. For example, over the past two decades, researchers in the United States and other countries, particularly Brazil, have debated the rate of deforestation in the Amazon rainforest. The answer affects calculations of the amount of carbon dioxide present in the atmosphere. In a NASA-sponsored study using Landsat data, this debate was effectively resolved, with the study showing that the rate of deforestation was, in fact, lower than many thought.

Our polar-orbiting satellites also provide information about the atmospheric cooling effects of volcanic emissions, specifically from the eruption of Mt. Pinatubo in the Phillipines. The extent and the duration of the effects of such natural phenomena on global warming must be considered in trying to understand fluctuations in the climate record. As a nation, we should take great pride in our ability to undertake policy-relevant scientific investigations designed to provide information necessary to, but not driven by, the policy debate.

- Space and Aeronautics. The commitment the Administration has made in space and aeronautics technologies reflects the critical role these technologies play in advancing U.S. economic, national security, and foreign policy interests.

The international space station is perhaps the Administration's most visible commitment to US leadership in aerospace technology. As you know, early in the Administration we undertook a redesign of the space station to reduce its cost, to improve its performance and safety, to accelerate its schedule, and to make it more relevant to today's economic and political climate. The inclusion of Russia as full partners in the station program reflects not only the benefits we believe can be derived from the incorporation of Russian space technology, but also the importance of broad international cooperation in the pursuit of fundamental scientific research. We expect that research on board the space station will provide important new scientific and technical insights and will lay the groundwork for mankind's next steps into space.

This Administration is also committed to making investments that will allow industry to dramatically reduce the cost of space transportation. In August, the President directed NASA to begin development of a new generation of launch vehicle technologies that could eventually replace the expensive Space Shuttle. The President also directed the Department of Defense to develop a strategy for evolving the existing launch vehicles into a fleet of vehicles that is significantly more cost effective. These government actions, combined with the energy and creativity of the private sector, not only holds out the possibility for much less expensive access to space for science, exploration, and national security, but lays the foundation for a reemergence of US industry as the dominant player in the commercial space launch market.

The Administration's commitment to space technology research has not lessened its commitment to space science and applications. Through its Global Change research program -- including NASA's Mission to Planet Earth program -- we will gain new insights into the fundamental processes of our planet. These insights can have a positive effect on our economy as we benefit from new knowledge of weather prediction, agriculture, disaster prediction, and other complex processes.

Besides exploring our own planet, NASA is planning a new generation of small, low-cost spacecraft that will provide new opportunities for exploration and discovery elsewhere in the solar system. These new programs, combined with our sustained commitment to important facilities such as the Hubble Space Telescope, will expand our already significant efforts to understand the nature of the universe in which we live.

The U.S. aeronautics industry has benefited greatly from its strong research and technology partnership with the Federal Government. U.S. firms lead the world in the manufacture of aircraft, engines, avionics, and air transportation system equipment. This leadership role has translated into hundreds of thousands of high-quality jobs and a significant contribution to our balance of trade -- more than $28 billion in 1993 on exports of $40 billion. The Administration's continued support for aeronautics technologies will help to ensure that U.S. industry remains a world leader in the development of new aircraft and engines. Federal R&D will also play an

important role in helping to ensure the development and implementation of a new, efficient, safe, and affordable global air transportation system. In particular, new technologies such as the Global Positioning Systems (GPS) will play a significant role in this process and may result in billions of dollars in annual saving to the airlines and a significant global market for new U.S. products and services. Finally, Federal R&D will help to ensure the long-term environmental compatibility of the aviation system. New technologies hold the promise of even greater increases in energy efficiency and further significant reductions in noise and potentially harmful chemical emissions.

PRINCIPLES OF THE FEDERAL S&T ENTERPRISE

Science and technology are essential to the various missions of the Federal departments and agencies. Looking to the future, our agencies must have a research and development base that will continually refresh and improve the ways in which we carry out our responsibilities.

Coordination and Streamlining

In order to confront the budgetary, scientific, and technological challenges of the 21st century, the Administration recognized that significant changes were needed in the way we plan and fund Federal R&D. The traditional single-agency, single-discipline approach to problem solving must be supplanted by a coordinated, multi-agency, interdisciplinary approach. Multi-dimensional problems can only be addressed by bringing together natural and social scientists, economists, engineers, and policymakers. For too long, science has been decoupled from informing policy decisions. Fixing this disconnect has been one of our highest priorities.

Over the past two years, the Administration has been working to improve the Federal R&D enterprise in many ways. For the first time, the United States has a comprehensive, coordinated Cabinet level body devoted to the Federal R&D enterprise. In November 1993, the President created the National Science and Technology Council (NSTC). The principal purpose of the NSTC is to:

- identify national goals that require concerted R&D efforts;
- identify the high-priority R&D needed to meet those goals; and
- coordinate R&D government wide to make sure that adequate attention is given to high-priority areas, and to avoid wasteful duplication

Although each agency, to accomplish its missions, must have R&D directed to its particular needs, there are some commonalities in the science and technology needs of all the agencies. Put another way, overarching national goals typically cross agency boundaries. This is particularly true because of the highly interactive nature of research and development with its many feedback mechanisms. The NSTC provides a structure in which to prioritize

the many legitimate demands on the public's R&D dollar. It assures a forum where critical national needs cannot be pushed aside by urgent and parochial agency needs. It can sensitize agencies to the advantage of symbiosis over isolated pursuit of objectives.

Through its nine standing committees, the NSTC has identified R&D priorities that link our S&T activities to critical national goals. Unprecedented cooperation among the member agencies plus a great deal of hard work in 1994 enabled these committees systematically to prepare research and development strategies to meet the goals. OSTP then worked with the Office of Management and Budget to ensure the priority areas received adequate attention -- all within a level R&D budget. The result is a coherent, efficient R&D agenda.

To meet the Nation's goals in the years ahead -- and to continue meeting them as the goals themselves evolve -- requires that we set priorities for R&D now, with a farsighted vision for the future because most of the S&T enterprise is inherently a multi-decade process. Even within the science community, it can take decades to recognize the significance of a scientific discovery. The NSTC provides the mechanism for providing the vision and deriving priorities. By creating a "virtual" S&T organization, the NSTC enables the Administration to maintain a productive research and development activity in each S&T-dependent agency while simultaneously achieving the efficiencies of a cross-linked system.

In addition to its beneficial impacts on the R&D budget, the NSTC has several important policy directives to its credit. For instance, the President has issued policy directives that will ensure continuity and efficiency in the Landsat and polar-orbiting satellite systems and ensure the appropriate agencies focus on the Nation's long term space launch needs.

All of the NSTC's work is undertaken in cooperation with the private sector. One of our key links to the private sector is the President's Committee of Advisors on Science and Technology whose members include eminent industry leaders and academic researchers, including Nobel Prize winners. Issues ranging from technology development to education and training to prevention of deadly conflict require close interaction between government and private sector experts to ensure ultimate success in our efforts.

Cooperation with the Private Sector

Technology is a powerful driver of economic growth. Over the past 50 years, at least a quarter of U.S. economic growth -- possibly as much as half -- came from new technology. These advances created millions of good new jobs, a cleaner environment, better health and longer lives, new opportunities for individuals, and enrichment of our lives in ways we couldn't imagine half a century ago. Superior technology, moreover, is vital to U.S. national security. In a world of ever tougher global competition, U.S. prosperity depends as never before on our ability to master new technology in areas like information,

biotechnology, and advanced materials and to build on S&T advances made in other countries.

Private businesses are the principal actors in converting technology to goods and services, to profits and jobs, and they have supported much of the research needed to develop new technologies. But the public (government) has three indispensable roles to play in advancing technology: 1) ensuring a strong base of fundamental science; 2) providing a business environment that encourages innovation and investment; and 3) investing in research that is critical to the economic and social needs of the nation, but cannot attract adequate private support.

The accelerating pace of technological advance, ever shorter product cycles, and rapid worldwide diffusion of technologies mean that many companies are finding it harder to justify investment in risky or lower yield R&D than in the past. Today, the payback to the investing company is often less than half the spillover, or "social return," to society at large.

This means that government R&D partnerships with industry in growth-enhancing technologies are more important than ever. Without government to share the risk at the pre-commercial stage, individual companies are reluctant to take the plunge, especially where a substantial fraction of the total return cannot be captured by a company. The government partnership fosters technology advance that otherwise might not be made -- or would be made in foreign countries, with most of the benefit going to their citizens.

In general, where there are technological risks, R&D projects with a strong combination of potential public and commercial benefits merit a mix of government and industry support. For example, education and training technologies that challenge and reward all our children and bring lifelong learning within reach of everyone have multiple public and private benefits: a better educated citizenry, a world-class work force, opportunities for people to retrain themselves in response to changing technologies and jobs, and a rich commercial market for the learning technologies themselves. Government's role in creating the National Information Infrastructure is not only to share the costs of R&D for basic advances in computing and telecommunication. It is also to make sure that privately financed information superhighways are accessible to all Americans.

The problem of capturing returns on private sector R&D investments is especially great in widely dispersed and fragmented industries such as agriculture or building and construction. Government must support technology advance in these industries, at least on a cost-shared basis, or it won't get done. This has been long recognized in agriculture, where government support of R&D goes back to 1862, with the foundation of land grant colleges across the nation.

Today, many in industry are taking a new, forward-looking view of their R&D programs. Corporate cost-cutting drives have led to focusing in-house research on technologies that are close to commercialization, at the expense of more basic, longer term,

or riskier research. The new model of best practice that is taking form is to create partnerships for riskier, generic, pre-commercial R&D -- teaming with other companies, with universities, and with the government.

We have re-invented these partnership programs to make sure that they are:

- market-driven, with industry leading the joint research agenda;
- cost-shared, with the private sector putting up half or more of the money, as a quasi-market test to make sure the technological risk is worth taking;
- competitive and peer-reviewed, to guard against pork in the selection of research projects; and
- evaluated periodically and rigorously to make sure that the projects are having the intended effect.

With the assistance of wise government policies, U.S. companies have recently regained a competitive edge in critical technologies, such as semiconductors, once thought lost to Japanese and other competitors. We must not return to the days when American scientists and inventors made breakthrough innovations, only to see the jobs and profits growing out of discoveries and inventions flow to overseas competitors. In a fiercely competitive world market place, it would be unwise to rely solely on those programs and policies that worked during the Cold War but are unsuited for today's needs.

THE LINK BETWEEN SCIENCE AND TECHNOLOGY

The Clinton/Gore Administration's science and technology initiatives are based on a recognition that science and technology are linked in a multitude of ways, each building constantly on the gains in the other domain. It is certainly true that all technological advance ultimately depends on fundamental science, and the highly trained people educated at our universities and colleges. But old distinctions between "basic" and "applied" science no longer make sense in today's laboratories, where, for instance, newly derived fundamental understanding of molecular biology quickly yields ideas for new products and manufacturing processes -- which, in turn, not only raise questions for further fundamental research but also give rise to new technologies that enable more effective research. And where progress in such fundamental fields as astronomy or elementary particles depend upon technological breakthroughs in optics, computing, or superconductors.

The relationship between basic research, applied research, technology development, and commercialization is not a linear progression. Rather, it is full of feedback loops. Often a technical or engineering advance will stimulate or enable scientific inquiry. For example, cars powered by internal combustion engines were running on the road before scientists began to understand, even imperfectly, some fundamental principles of combustion. Magnetic resonance imaging was founded on basic research in nuclear physics -- but it could not have been put to practical use in medical diagnostics without the separate but parallel development of a number of sophisticated technologies, especially the microprocessor, the

"computer-on-a-chip" that could be built directly into the instrument. The cancer treatment drug taxol is derived from the yew tree of the Pacific Northwest, and without the research to classify and study the natural plants and animals it might never have been found. And most of today's experimental science has become totally dependent on the most recently developed technology.

The search for something practical often forces a new look at the scientific principles that underlie new phenomena; the prepared mind is ready to take a leap into the practical application. Ernest Shockley, an AT&T Bell Laboratory physicist, invented the transistor while engaged in a lab program to develop better switches -- but the scientific work of previous decades on solid state physics and quantum mechanics was absolutely essential to the invention. The early age of science provides equally interesting examples. Galileo, who developed fundamental knowledge of astronomy, was also an inventor who spent much of his time and energy demanding payment for his practical inventions.

The blending of discovery and application is repeated across virtually all science and engineering -- from biomedicine to environment to space exploration and aeronautics to materials and manufacturing. Basic research on materials results in stronger, long lasting roads and bridges and lighter, but safer airplanes and cars. Today's wonder drugs and tomorrow's bioremediation of chemical wastes are direct products of our continuing investments in biology, chemistry, physics, and earth science.

The fundamental point is that basic science, applied science, and technology, though different in approach, motivation, and scale, are profoundly interdependent.

CONCLUSION

Mr. Chairman, we welcome the opportunity to engage in a dialogue with Congress, with all Americans, about the value of our investments in science and technology. Like you, this Administration envisions a future of sustained and responsible growth of the U.S. economy based, in large part, on new discoveries and improved technologies derived from those discoveries.

There has been and will continue to be strenuous debate about the appropriate role for government in science and technology. Some people believe that fundamental science -- basic research -- is the only area in which government belongs. As I have already said, this Administration does not believe it benefits the American people to try to draw that line in the sand. The Clinton/Gore Administration believes government has an essential role in technology development as well. Economic growth, quality of life, national security -- all these things depend on a comprehensive science and technology investment program. For our children and grandchildren to succeed in the knowledge-based, highly competitive global economy, the Federal government must maintain a strong commitment to investment in the future, in other words, to investment in science and technology linked to long term goals.

We are convinced that technology is the engine of economic growth that will ensure good jobs and a higher quality of life. We know that scientific knowledge is the key to the future . . . it is the fuel for the engine.

The Cabinet Secretaries and Agency Heads here today will all agree that the Federal Departments and Agencies are working together in unprecedented cooperation to provide essential science and technology services to the American taxpayer in an efficient and cost-effective manner. The "virtual agency" created by the NSTC eliminates duplication and waste and gets maximum advantage from each investment dollar. Budgetary constraints have made the workings of the NSTC absolutely essential, and we have succeeded in shifting resources to enable the S&T portion of the budget to be maintained and even slightly increased in key areas.

We know from your record, Mr. Chairman, that you, too, support science and technology and recognize the vital role they play in the future of our economic, environmental, and national security. But in looking at the Contract With America, along with the FY '94 and FY '95 Republican budgets and other proposals for paying for the Contract, we are concerned. The Clinton/Gore Administration shares your commitment to reduce budget deficits and the inefficiencies in government. We have worked, with great success, to bring the budget deficit down, to cut government employment and spending. But we have also taken great care not to sacrifice our investments in the future -- in the well being of our children and grandchildren -- in the process, by commiting ourselves to sustained support of science and technology.

Our initial interpretation of proposals to fund the Contract With America raises our concerns that we will not be able to develop and disseminate the education technologies our children will need to compete in the global, knowledge-based economy; that we will not be able to invest in research that could ensure this Nation's continued preeminence in industries dependent on biotechnology or information and communications technologies; that, in fact, between now and the end of the century this Nation may find itself in wholesale, devastating retreat from the investments on which our future depends -- inveistments in science and technology. This Administration will stand against that retreat because it cuts to the core of our guiding premise: we must invest in our children's future in ways that promise the highest payoff.

We are a nation of explorers. We need science and technology to nurture our national soul as well as our economic well being. The Clinton/Gore Administration wants to work with the Congress to achieve the goals of the American people, including long term economic growth, an efficient and responsive government, and world leadership in science, engineering, and mathematics.

Thank you.

The CHAIRMAN. Thank you very much, Dr. Gibbons.

The Chair has been lenient with regard to the five-minute presentation rule in large part because the witnesses I think did testify in the spirit of the hearing and I thought presented excellent testimony, and I deeply appreciate the testimony that you presented, some of which may prove controversial as we go to questions. I would like to proceed with that at this time.

Let me talk a little bit about the ground rules. I think we will proceed with the five-minute rule. We have had an excellent turnout of Members this morning. I will begin with Mr. Brown and then we will proceed to each of the people in the order in which they appeared at the committee for five minutes.

If we can and there are still some people with some additional questions, we will go to a second round after that period of time.

We want to be somewhat concerned about the time frame of all our distinguished witnesses, all of whom have agencies to run. We would like as many Members as possible to have an opportunity to get all their questions done.

With that, I would recognize first the Ranking Minority Member, Mr. Brown.

Mr. BROWN. Thank you, Mr. Chairman. I would point out that you set new standards of quality in the conduct of hearings. We have disposed of five very important witnesses in less than an hour and still have an hour and a half for questioning. That is very good.

Let me ask a couple of questions.

First of Ms. Browner. As you know, the risk assessment question achieved quite a bit of prominence during the last session of Congress. This committee passed out a bill—did it pass the House? It passed the House and might have passed the Senate except for the time restrictions. Can you elaborate a little bit on what elements you believe would be most helpful in any legislation dealing with questions of risk assessment?

Ms. BROWNER. Mr. Brown, I would suggest that—and the administration is prepared to work with the committee and others to support legislation that would aim to improve the science of risk assessment but to do so in a way that is not overly prescriptive, allowing for scientific advancements and improvement. That calls for improved communication and requires agencies to prepare, review and publish guidelines for how they will undertake these assessments.

Mr. BROWN. Well, we anticipate that we will be moving legislation in this area again. It is on the list that the Republicans want to move, and we express a hope that we can collaborate with you as we develop that legislation so that it meets all of our needs as effectively as possible.

Let me address one question to Dr. Gibbons and that will be adequate for me, I think.

Dr. Gibbons, there was a disturbing three-part article in the Post over the Christmas vacation, which most of us missed because we were not here, but I have subsequently read it. It paints a disturbing picture of the situation with regard to funding of research and development in this country for the future and for the opportunity for employment as scientists and as engineers in this country for

the future. And the question that I would like to have you discuss just briefly is, in the light of your statement that we have been operating a zero sum game, is this going to solve the problem of maintaining our leadership in world research, at least in critical areas, which is our goal, as you know, and in providing adequate employment opportunity for our best scientific knowledge, our young scientists who are coming on the market? Or should we have a different goal, and if so, what should it be?

Mr. GIBBONS. Mr. Brown, we still maintain a healthy lead generally in science and technology around the world, and it has served us very well, and I think we all can stipulate to that.

The concern you express, which is very important, is that is the vector on which we are moving carrying us in a way that we are slowing going to be eroded to the point that others, that we will lose that edge on which we increasingly depend in the future.

Mr. BROWN. That is correct.

Mr. GIBBONS. I think everyone is examining what we can do with tighter funds. It is a little bit like, I believe as Samuel Johnson talked about: The night before the hanging doth focus the mind. And I think a lot of minds have been focused not only in our industry as they face the increasing global competition, but also in our universities as they consider how well they can prepare their graduates, to find well-trained graduates, but at the same time marketable commodities in the working place of tomorrow.

You and I, the rest of us, are working on how we can reoptimize these increasingly tight resources within the Federal coffers to make the most of them. And what we are trying to do in the Science and Technology Council is to go on basically an initial assumption, this has been almost for two years now, that we are dealing with the same number of dollars. Therefore, agencies and the administration must either increase efficiency, if it wants to start something new, or stop doing something that it has been doing that is less important than something that is new. And these two options have led us to reshape a number of programs across the Federal Government and for certain we are having to drop off some things that are very interesting but are less important, we feel, than others.

In terms of employment, I would say this: It is taking a longer time for graduate students to find—for recent graduates to find jobs and for those displaced in science and technology to find jobs. But the overall unemployment rate there is still considerably less than in other sectors of our economies, so it is still a good direction to go for employment. But I think we have to understand that we are trying to—that there is no one that is going to escape the squeeze on trying to get our resources more carefully used in our society.

My concern is, and that is the reason I applaud Mr. Walker's focus on the next two decades, not just the next two years, is that our decisions today, in effect, set our vectors for what is going to happen in science and technology and its fruits 20 years from now, and we need to be thinking about what the implications are of this very disturbing trend now toward fewer and fewer resources going into our seed corn.

An inescapable result is that we are going to end up less well off than other countries that do not make that same move, and I think our concern with you in this coming spring now is to try to see if we cannot understand ways that at least within the Federal family and its new relationships with the private sector, together we cannot build a way of getting more for less, because I fear that is our future.

Mr. BROWN. I would just comment, Dr. Gibbons, I agree with your analysis, that the administration, in its reports to the Congress has set certain goals, which I would call rosy scenarios, which are not very practical, and I can tell you that if you continue merely to set impractical goals without setting forth the path to achieved those goals, I am going to be as critical of the administration as any Republican is, and I am not going to like playing that role but I am going to do it anyway.

The CHAIRMAN. I thank the gentleman. The gentleman's time has expired and I recognize the gentleman from Wisconsin, Mr. Sensenbrenner.

Mr. SENSENBRENNER. Thank you very much, Mr. Chairman.

I think that all of us know that our legal system is one of the impediments to increased productivity in the American economy, and some type of legal reform is necessary if we are to keep our technological edge over our international competitors in the next 20 years.

And, Secretary Brown, I would like to ask you specifically if you or the administration is going to support some type of comprehensive reform program of our legal system, including, but not limited, to tort reform proposals?

Secretary BROWN. As you know, Mr. Sensenbrenner, we have been open to suggestions that we look at a number of vehicles for change. The administration has not taken a formal or official position on the subject of tort reform.

As you know, in the health care reform package last year there were some steps in that direction, in recognition of the problem. So we look forward to working with the Congress to try to look to the future, to try to determine what the real impediments are to economic growth to make a determination as to whether this is really one that ought to be not only reviewed with you that we should take action on.

Mr. SENSENBRENNER. Let me give three concrete proposals. First, caps on noneconomic damages, such as punitive damages in pain and suffering awards; no caps on economic damages, like lost wages or medical bills, both present and future, but on the noneconomic damages; second, changes in joint and several liability rules, so that he who is at fault pays and he who is not at fault does not pay; and, finally, adoption of the English rule that the loser in civil litigation pays. England has 98 percent fewer lawsuits because the loser pays rule makes it quite plain both to plaintiffs and their attorneys that if they go to court and file a suit that does not have merit and does not have a significant chance of success, they are both going to be on the hook for the cost of defense of the person or the corporation that they have sued.

I think that each of these three items would have a significant impact in making us a less litigious society, and we know that all

of those litigation expenses are folded into the cost of goods and services that America sells not only to our own people but to people overseas. And I would hope that the administration would favorably consider this entire area and these specific three proposals because I think that that is going to be one of the keys to having the vibrant economy in the year 2015 that all of us desire.

Secretary BROWN. Well, I certainly respect your point of view. As I have indicated, we are open to reviewing all of those suggestions. Those are three that are being discussed, have been discussed over time; they are ones that we have paid a good deal of attention to. We agree that this society is too litigious. We need to evaluate the impact of that on our future economic growth and ability to create jobs for our people.

Mr. SENSENBRENNER. I would respectfully submit that the time for studying this issue is over and the time for making some decisions is at hand. The whole issue has been studied for as long as I can remember, and I think we ought to be voting on some of these issues and perhaps doing something on this subject, and I hope that there would be a partnership between the administration and Congress on it rather than simply attempting to shove the matter off to some future time with another study.

Secretary BROWN. Well, there will be a partnership on all matters of importance to the economic future of our country. You can count on that.

As you know, the Congress can vote on these matters as it chooses and the administration then has to make a judgment as to whether to support one position or another.

Mr. SENSENBRENNER. Well, let me solicit your support in the councils of the administration for these three specific proposals so that if and when a bill is passed by the Congress it meets with the Presidential signature rather than being sent back to us with a veto message.

Thank you, Mr. Chairman. I yield back the balance of my time.

The CHAIRMAN. Thank you, Mr. Sensenbrenner. Mr. Weldon of Florida.

Mr. WELDON OF FLORIDA. Thank you, Mr. Chairman, and I want to thank all of our speakers today for this very informative and inspiring message.

My question is to Mr. Goldin. As the representative from the area that includes the Kennedy Space Center, one of the areas that I have been concerned about is having a vision for the future, and I very much enjoyed the vision that you laid out today because I feel that it is very important for the people working in my district in the area of space to have a vision for the future.

One of the reasons why I feel that is very important, and maybe I could ask you to comment on this, is in terms of maintaining morale. Morale at the space center at this time is somewhat low, mainly because of the tremendous numbers of studies that senior personnel have had to do in terms of finding ways to control costs; and, additionally, naturally, many of the workers there are very concerned about their jobs and the future for themselves and their families.

So if I could ask you to comment on that, what we can be doing, if not 20 years from now, at least in the next 2 years to help main-

tain morale not only in the agency in general but as well in places like Kennedy Space Center.

Mr. GOLDIN. First, let me say that the people down at Kennedy are just outstanding. They have a very difficult job to do. Normally, in the white collar world, if you make a mistake, you just take out a pencil and eraser and you can erase it. At NASA-Kennedy, the whole world watches what they do, so the morale of the people at Kennedy is very important.

On the other hand, America has said they want government to be more effective, and when government has to be more effective, we have to make some very hard decisions. We could make decisions in the absence of data without studying it, and I know there is a very high level of frustration among the staff at Kennedy, but if you take a look at the NASA budget, we cut it 18 percent in 1994, 12 percent in 1995, and we are now working the 1996 budget and we have another clear message from the voters.

So we have elected to work with the employees to try and understand what is the right thing to do. Everything is on the table. Wherever we can efficiently eliminate inefficiency, we will.

As an example, as a result of the study, we found 183 people sign off on launching the shuttle. That does not enhance safety, in my mind. It takes away accountability and responsibility. So, as a result of these studies, there will be one person at NASA-Kennedy that will sign off and be responsible.

So we will try to get this done, but the most important thing we can do working with this Congress is once we settle on what the budget is, let us have some stability. We have called for that. If we constantly ratchet the budget, we will never ever catch up. So we would like this to be our last exercise in about five years and that will be the single most important thing to help the morale down at NASA-Kennedy, if we work together to stabilize the budget.

Mr. WELDON OF FLORIDA. Thank you, Mr. Goldin. I yield back the balance of my time, Mr. Chairman.

The CHAIRMAN. I thank the gentleman. The gentleman from Indiana, Mr. Roemer.

Mr. ROEMER. Thank you, Mr. Chairman.

In the spirit of the new Speaker, Mr. Gingrich, I would like to start by talking about a couple of books. He mentioned five or six books the other day in his address, and I guess the first one I would mention would be Daniel Borsten's The Discoverers, and the excitement and the thrill that goes into discovery and the importance of technology to this Nation's capacity to be the strongest Nation in the world. And I strongly recommend that book.

The second one, in light of the dialogue that just went on between the new Member from Florida and the director of NASA, would be Mr. Bennett's, The Book of Virtues, and that would be character and honesty and so forth, which we are going to need a lot of in the next two years to make some of the tough decisions that are going to come to this committee and other committees where, to balance the budget, it is going to cost several hundred billion dollars. If the votes are there to pass the Contract for America, again several hundred billion dollars. And if tax cuts for the middle class are passed—which, by the way, I believe that the best tax cut we can give to the middle class is to continue to keep the

deficit down so that we let people buy a home and refinance a home and keep their jobs and keep the economy going—we are going to have to make some tough cuts in some of these programs.

And while the dialogue that just took place is nice to hear in terms of vision, the reality is Mr. Goldin said that he has already experienced a 30 percent cut in NASA, yet he wants to see an industrial park in space, schoolchildren operating robots on the moon, replacement for Apollo, laboratory on an asteroid.

I don't know how we would do it, Mr. Goldin. I would love, with two children of my own, who are 22 months old and 6 months old, to think that we can do all these wonderful things. I do not know that we can.

My question to you is with the 30 percent reduction already in your budget, with having to fund what I have just talked about with this new agenda before us, you are going to have to continue to make some cuts and some of these cuts are going to come in the science budget that has already experienced tremendous cuts under NASA in the last few years. I have tried to make some of the tough choices by proposing elimination of the Space Station. You and I have disagreed on that particular proposal.

Mr. GOLDIN. Strongly.

Mr. ROEMER. We have strongly disagreed. We will strongly disagree this year on that same proposal once again, because I will continue to put that before this Congress as an honest option for moving toward a balanced budget, and maintaining Dr. Lane's programs of investment in R&D at the National Science Foundation, where he is going to take inordinate cuts to pay for some of these other proposals.

So my question to you and Dr. Lane would be how are we going to move toward these tough decisions? What recommendations do you have not just of a vision for the future but virtual reality? How are you going to make these cuts in your budget and, Dr. Lane, the question to you would be do you see this, roughly out of your $3.2 billion budget, $2 billion going to R&D, are you going to have to cut that? And what recommendations might the panel make in terms of eliminating regulations that unnecessarily encumber R&D investment in new technology and encourage cooperation between government, industry, and academia?

Mr. GOLDIN. First, let me say that I want to add to what Dr. Gibbons said in the new parlance where we have declining budgets. You get efficient, you prioritize, and you measure output, not input.

One of the things we have to rid ourselves of is how many dollars are we putting in and how many people are working on the program. I intentionally said that what we have to set our vision on is how we are going to create jobs for children 20 years from now, not how many people are we going to employ.

I would submit that if this committee is willing to work with NASA and change the policies, there is lots of room to eliminate a lot more unnecessary things that we do. We do not need thousands of people in NASA-Houston operating spacecraft. We do not need a thousand people or 500 people out at JPL watching a spacecraft as it goes between earth and the planet Saturn.

We at NASA are committed to revolutionary change. Revolutionary changes hurt because when you make revolutionary change you

rid yourself of the old ways and you get rid of the power structure. We are committed to doing that, and I think we are going to have a better agency.

And, lastly, I would like to say the science at NASA is better today than it was three years ago. We started more scientific missions in the last few years than we did in the prior five. They are not billions of dollars, they are hundreds of millions. In fact, one of them is a mission for $59 million to put a 384 spectral line sensor into orbit that is less than an order of magnitude of the Landsat program. What you get out is what is important, not what you put in, and I know that we can do it.

I didn't propose starting a new Apollo program. I said we would have the ability to make the decision. We will pay as we go. I know that we can revolutionize NASA. Do we all have the stomach to make the hard decisions that have to be made? That is the question we ought to ask.

Mr. ROEMER. I would only say, Mr. Goldin—

The CHAIRMAN. The gentleman's time has expired. And if he wants Mr. Lane to answer the question he asked him, I will say I will allow Dr. Lane to respond, but the gentleman's time has expired in terms of the dialogue. Does the gentleman wish to—

Mr. ROEMER. So I do not have time to respond to Mr. Goldin at all?

The CHAIRMAN. Your time has expired.

Mr. ROEMER. That is why I debated this new rule.

The CHAIRMAN. Well, this was not the new rule. This is the old rule that has been around for 40 years, called the five-minute rule.

Mr. ROEMER. But you are enforcing it.

The CHAIRMAN. I will recognize Dr. Lane to respond to the question that Mr. Roemer asked of him.

Mr. LANE. Mr. Roemer, we certainly understand that given the constrained budgets we are looking at and the continued efforts to reduce the deficit, that we at NSF will likely participate in that. We are likely to have to look at lower budgets.

I certainly agree with what Mr. Goldin has just said about the importance of setting priorities. That must be done. I would say our focus on that will be to keep excellence foremost in our decisions to ensure that our programs come as closely as possible with educational missions of the agency to encourage interaction with industry where that is mutually beneficial; where that makes sense. It is not something we push to industry, that is something industry pulls. We simply want to make sure, however, that the barriers are not there, and that we coordinate. And this is, I think, very—I do believe deeply in the importance of doing this; that we better coordinate our activities with those of the other agencies.

The process that we have engaged in through the National Science Technology Council is working. We have a good start. It is a way to ensure that we do not have unnecessary redundancy in place and that our programs and our people are really able to work together. That is the way we will maximize the benefits of the investment.

The CHAIRMAN. Thank you, Dr. Lane.

Mr. Hastings of Florida.

Mr. HASTINGS. Thank you very much, Mr. Chairman, and thank you for holding this hearing.

I certainly want to thank all of the witnesses who have presented us, in my opinion, with some extremely exciting proposals. Lest we not underscore the divergent opinions that exist in the United States House of Representatives, I normally do not comment when a colleague has left the room, but I would like Secretary Brown to know that my colleague, Mr. Sensenbrenner, for whom I have the utmost respect, and I have total disagreement with reference to tort reforms, specifically in the loser pays. I am already in debt and I would be in a hell of a lot of bad shape if I had to pay all of the ones I lost, by and large. I just wanted you to know that, Mr. Secretary.

With reference to the elimination of the Space Station, I have equal respect, admiration for, and am fond of my colleague, Tim Roemer, but I guess coming from Florida I have a totally different view than he does with reference to the Space Station.

We are in budgetary constraints and, obviously, are going to be required to exercise priorities. In my considered judgment, if we do not prioritize with reference to research and development and do not understand the dynamics of the programs that have been presented to us by the various presenters this morning, that we are going to find ourselves in the next two decades woefully inadequate, not only in the global competitiveness that we are confronted with, but even within the framework of our own systems.

Secretary Brown, the advanced technology program is often accused of pushing the Federal Government into industrial policy and subsidizing product development when that should be industry's job. Can you give us a brief summary—and this will be my only question, Mr. Chairman—answer for us what the advanced technology program is and what the ATP is.

Secretary BROWN. That is a false charge. It is one that we have attempted to try to counter for the last couple of years, one that the Bush administration tried to counter because the program was initiated in the Bush administration.

The fact is it has nothing to do with industrial policy, it has nothing to do with picking winners and losers. It has most to do with keeping us on the cutting edge as far as technological innovation is concerned.

We have been a Nation that has been very successful in producing Nobel prize winners. We have been less than successful in commercializing technology. We have been less successful in transferring technology and getting technology in the hands of small and medium-sized business people. We have been less successful in generating profits and jobs from technology.

We want to deal with precompetitive technologies that are not easily funded through venture capitalists that would not see the light of day but for a government private sector partnership. We are committed to that partnership. We think it is the key to our economic future and nobody gets a free ride.

You have to remember that these companies are putting up 50 percent of the cost, and much more when you really do an analysis of the spending that is taking place. I think we have proven time and time again that the things being done are much like the exam-

ple I used in any oral testimony and these are things that would not take place, that would not see the light of day. This would not be here. The company that did this that had the innovation, that had the dynamism, this would not have been produced. We would not have explored a whole new area that allows not that company but a whole industry to proliferate.

That is what this is really about. It is about the question that the Chairman appropriately asked. It is how do you look to the future; how do you look to the future and have a road map for getting there. The road map is public-private partnership. The road map is the government filling the gap that exists between that $83 billion that is expended annually in the private sector for R&D and the $70 billion that we are expending from the public sector. An overwhelming part of that is going for defense-related activities, and one of the things that has not been mentioned in some of the responses is we are trying to change that equation, too. It is 60-40 now, military versus civilian. We would like to take it to 50-50. I would like to take it further than that.

I think we need to focus on the commercial interests of the United States with the full understanding of the fact that our national security is more and more interrelated, interdependent with our economic security. And if we keep that focus, it seems to me we have to conclude that programs which spend the ATP program is less than 1 percent of Federal R&D spending. We get more bang for the buck in a program like that, I believe, than almost anything that the Federal Government does because it draws a connection between that $83 billion and that $70 billion, and it makes sure there is not a gap, and it makes sure that we can prepare for the future of 2015 and beyond.

Mr. HASTINGS. Thank you very much, Mr. Secretary.

I would like very much if you would allow a staffer to help edify my office with reference to the National Institute of Standards and Technology. And I mean that. I don't know very much about it and I am genuinely concerned.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you. Gentleman from New York, Mr. Boehlert.

Mr. BOEHLERT. Thank you, Mr. Chairman. I think this hearing has the right focus. We are looking long term, as Dr. Gibbons stressed and as Chairman Walker expressed, rather than in thinking just in terms of tomorrow. And as Administrator Goldin pointed out, the Class of 2015 is one year old today. I am concerned about those one year olds today. So let us begin at the beginning.

I would like, Dr. Gibbons, for you to comment on the associated press report this morning that had some very disturbing news. It says only 81 of the 289 teachers who took the first-ever national teachers test scored high enough for certification.

Now, we know their older brothers and sisters do not measure up when compared to their counterparts around the world in science and math proficiency, but that is a great concern to all of us. All the fine talk we have here about this exciting venture of the future are going to be more naught if we do not educate the adults of the future.

So let us begin at the beginning. Dr. Gibbons, would you please comment on what more the administration and we should be doing to promote and foster science and math education specifically?

Mr. GIBBONS. First thing we have done is to try to combine the collective resources of the Department of Education, The Science Foundation, the Department of Labor, and the Department of Defense, which is probably our largest enterprise, in fact, in training and education into a single group under the National Science and Technology Council, to pool their resources and perspectives in devising ways to accelerate the introduction of particularly computer-based technologies as aids to instruction in K to 12 as well as other parts of our educational system and in training. Because education now is a lifelong process.

You and I typically maybe have gone through two careers. Our kids will have gone through four careers by the time they end up. Therefore, the very nature of education is to train not only in-depth but in versatility. And we believe that there are enormous opportunities of advanced technologies, and that is an appropriate role that the Federal Government can play to help develop these technologies and help the States and local communities, where the bulk of the responsibility lies, to introduce these and make full use of them.

We are working hard on the national information infrastructure which gives the teachers and the students the capability to Internet across schools, to form virtual classrooms, and to reach out and do some of the sorts of things already that Dan Goldin just spoke about. So we are trying to play the appropriate Federal role by combining these agency resources under the NSTC.

And I share with you a great deal of concern about the status and I think that latest news about the capability of our science teachers only underscores the need from the community level all the way to the Federal Government to be concerned about who it is that is teaching our kids, not only in the classroom but what is happening when the kids go home.

Mr. BOEHLERT. Which brings me to another point. When those one year olds get to be 20 years old and they are at our universities, I am concerned about the quality of education they are receiving. And, Dr. Lane, I want you to address this. I am very concerned about undergraduate education in America today, because of the undue attention being devoted to research by some of the finest minds that we have available in our universities rather than spending time in the classrooms helping to nurture the minds of the future researchers.

Would you talk a little bit about what your agency proposes to do to place a greater emphasis on undergraduate science education?

Mr. LANE. Well, I think the problem obviously is a very real one, that we do not have to go back too far to find a time in our universities when very little attention was given to the quality of education of future teachers. One might even in a given situation suggest that all undergraduate education was not given the attention it deserves. I think that is changing on both counts.

I go around the country a good bit and talk to faculty and administrators and others in universities and colleges, and the message

I try to carry is the one about breaking down all of these artificial barriers, the barriers between research and education on a campus.

Mr. BOEHLERT. We need to push the universities. Because it is all well and good to have the catalogues announce all the stars that are available on campus, but if they are spending all their time in the lab and no time in the classroom, the generation that we are concerned about, the next generation that are going to do all these exciting things that Mr. Goldin and others have talked about, they will not be prepared to do them. So can you give them a little push?

Mr. LANE. That is why it is, in fact, included in my earlier response in connection with what is going to set our priorities, the priorities for our programs, is that excellence is going to drive them but coupling with education is critically important and I meant all education.

So one might ask the question, why is it so important to have research going on in an university environment? Why not do all our research someplace else? The reason you want it done there is because of its value to education. You want the students in the laboratories and you want the faculty in the classrooms. That interaction has to become stronger and we can play a role to help there.

Mr. BOEHLERT. Thank you.

Mr. Chairman, I used to think that five minutes went by quickly in the Minority; I find out it goes by just as quickly in the majority.

Mr. ROEMER. There is an opening here any time, Mr. Boehlert.

The CHAIRMAN. The time of the gentleman has expired.

Do I understand that Ms. Rivers from Michigan is—okay, she has left. Ms. Harman from California.

Ms. HARMAN. Thank you, Mr. Chairman. I want to commend you and your staff for preparing an excellent hearing charter. I think this is the best effort I have seen to pull together information about what is going on on this important subject in the executive branch.

And to the witnesses, let me start with this: My youngest child, who is 10, came to me the other day with a great insight, and she said, "Mommy, my children are going to be born in the next century." It makes you pause. It is not just that we should worry about our children and what happens to them in the next century, but they are worrying about their children.

On that note, I do want to commend the witnesses not only for today's testimony but particularly Secretary Brown, and Mr. Goldin, for your tireless efforts to reform your own agencies against all odds and to travel the countryside, and in your case Secretary Brown, the world, to try to help our businesses, U.S. business, and U.S. interests develop and thrive, and in your case, Mr. Goldin, to try to teach our children to dream about the future in space.

My question is this, and it builds on a comment that Dr. Gibbons made. You said, Dr. Gibbons, that private businesses are the principal actors in converting science and technology into goods and services and jobs, but the public sector also has important roles.

I agree with you, and my question is this: The public sector has important roles, obviously, to undergird public investments in space and in our national security program. But the other important role, and Mr. Hastings was asking about this, I think, is to

share public technology with the private sector and to promote commercialization.

Could some of you, and maybe I should start with Mr. Goldin since I don't think he has addressed this, tell us more about the ways in which NASA helps with commercialization?

Mr. GOLDIN. NASA has a major impact in commercialization because one of the things we do is develop new tools. I alluded to the fact we are working on calculations today that will need computers a billion times faster to perform the scientific analysis of the environment on planet Mars or understanding Saturn or its moon, Titan.

In the process of doing that, we develop technologies and capabilities second to none in the world. I will give you an example. The CEO of Silicon Graphics came to me and said, Dan, I located my factory right across the street from NASA-Ames so I could get the synergism of working with them. NASA-Ames buys their advanced computers and beta tests them. He is able to see where the bugs are. He takes advantage of our advanced technology. The symbiotic relationship is across the agency.

We have a business incubation center at NASA-Ames and we have venture capitalists who are providing the seed of the process. We have 14 new companies that have started up in this incubator and we predict 5,000 jobs will come out of that one effort alone. NASA-Marshall and NASA-Kennedy have banded together on tech transfer in a productivity center, and they predict 20,000 jobs over the next three years generated by direct transfer of NASA technology.

So we believe we pay as we go our own way. And if you take a look at testimony from a GM executive last year in the Senate, he testified with me, he said GM today is using NASTRAN, a structural modeling program that we developed to build the moon rocket. They are using it today and it is 30 years old.

Ms. HARMAN. Does anyone else have a comment?

Mr. GOLDIN. I think Secretary Brown had a comment.

Ms. HARMAN. Secretary Brown.

Secretary BROWN. I would just say the question is a very appropriate one; that we have to figure out how we make this partnership work, how we get technology in the hands of the private sector, how we commercialize technology, how we use it as a driving force for economic growth and job creation.

I happen to believe that the Department of Commerce is, in effect, a civilian technology agency. That has been our job. That has been our role. We have not had the kind of mission oriented role or defense oriented role that other agencies of the Federal Government have and, therefore, our job has been to interrelate with the private sector over time. We have tried to be more effective at that over the last several years, and I think an objective analysis would indicate that we have had some significant successes.

When you look at several areas, one NTIA, our National Telecommunications and Information Administration, all that we do there is work with the private sector to make sure that as we build this national information infrastructure we do not create a society of information haves and information have-nots but that we encourage investment, that we encourage competition, that we en-

courage the ability to interconnect, interoperability, and that we encourage universal access. That comes through the private sector. They build the national information infrastructure.

When you look at NOAA, and all the work NOAA is doing in environmental technology, again working with the private sector, our space efforts, our satellite efforts, the work that Keith Calhoun Sanghoid does in the Office of Space and Commerce, again focused exclusively on how we commercialize. Something that the Chairman has been very interested in.

As a matter of fact, at the beginning of the hearing I walked up to him and presented him with the first photograph taken from our most recently launched satellite, which has special significance about the future and about commercialization in the space area.

Finally, when you look at NIST, an agency that obviously is spread all over the country but has a big presence in Congresswoman Morella's congressional district and the work that they do, not only through the NIST labs, again relating directly to the private sector, not only through the ATP program, which I have described, and the manufacturing technology center which I have described, all of those stress, focus, on the interconnection between the public and private sector, how we leverage Federal dollars to get maximum impact, with the full understanding that this partnership has to be based on the premise that it is the private sector that fuels the engine that pulls the train of economic growth and job creation in America. There is no question about that in our minds. We understand that.

But we in government can and must be better and more effective partners and we are doing everything we can to make that partnership stronger, to be better and more effective partners, to take limited Federal resources and leverage them in the interest of the American people.

The CHAIRMAN. Time of the gentlelady has expired.

Ms. HARMAN. Mr. Chairman, I understand that—would it be all right for Ms. Browner just to answer my question, because I think she had something to say as well? I have no further comment.

The CHAIRMAN. If we can make it brief. We are well behind in terms of all the people that want to participate.

Ms. BROWNER. I will be extremely brief, Mr. Chairman.

At EPA, our environmental technology initiative is in a very exciting opportunity for two reasons. One, because of the world market for environmental technology. Today's world market is $300 billion. It will grow to more than $600 billion by the end of the decade. The United States is not number one in the exports of environmental technology. Japan and Germany surpass us. That should not be the case. We are working with industry to get those technologies commercialized, to get them out across the globe solving environmental problems.

Secondly, what new technologies can do for us here at home. I will give you two quick examples. The metal platers. We have been working with that industry, a small business in many instances, to find pollution prevention answers. Not merely to help them comply with regulations but to prevent the pollution in the first instance.

A second example, local government. In California, a small town of approximately 70 people was having a lot of problems with their

drinking water supply. They could not get rid of the bacteria, the parasites in their drinking water supply. Working with the private sector, we helped to see a technology developed and commercialized which allows this town to provide safe drinking water to all the people at 40 percent less than conventional technologies. Very exciting opportunities.

The CHAIRMAN. Thank you. Ms. Lofgren.

Ms. LOFGREN. Thank you, Mr. Chairman. This is my first hearing as a new Member of Congress and I am happy to be here representing Silicon Valley, where not only the industries but the citizens themselves strongly believe in investing in research of all sorts, from pure basic research to technology and innovation. We understand that sometimes this is costly but it can never be as costly as ignorance. We also understand that the science and technology really are the key to our future as a country and to the economy of the next century.

I think about the premise of this hearing, which I give much credit to the Chairman for calling, but I also understand that we cannot know what the future will bring. It is the very nature of research and science. I do not think that those working on ARPANET in 1970 really envisioned the information superhighway that we are working on now. And the information superhighway, I believe, is really a key to the expansion of our economy, at least here in the near term.

Having said that, I think about how we can broaden the participation of all Americans in the prosperity that technology brings. And a concern that many in Silicon Valley have is the creation and growing two tier society in information technology in particular.

I am wondering what strategies the administration has to make sure that technological information and access to technology is broadly available to every sector of our communities. Mr. Brown, could you answer?

Secretary BROWN. I will start. One of the things that we are attempting to do through the National Telecommunications and Information Agency, and also through the work I do in leading the Federal Government's effort in this area, is really to assure that we can close some of the gaps that exist in our society rather than make them wider.

One of the gaps is an educational gap. How do we use telecommunications technology to deliver educational services. How do we close some of the gaps in health care delivery. How do we, as we did not too long ago, when I went out to Fairfax Hospital in Northern Virginia and we are hooked up through a telemedicine experiment with rural West Virginia, doing some diagnostic tests that could not have been done in that rural part of America. But also how do we deal with getting this technology in the hands of those entrepreneurs who are going to invest and actually build our infrastructure.

The NTIA grant program is one way to do that. In effect, it drives demand. There are some things, believe it or not, that are not always so apparent to entrepreneurs, that there is money to be made in a lot of areas that have not been thought about. How do you call that to the attention of the private sector?

And one of the things with very nominal expenditures of money that we have been able to do is to really create an interest in investment in an area that does just the things your question alludes to, how do you make sure that you get maximum use of this technology and that it is not just concentrated by region or by economic group but that all Americans have an opportunity to benefit from that technological innovation.

Ms. LOFGREN. May I ask further, thinking about Jane Harman's comment earlier. I am convinced of the value of research, and there is a lot of transfer going on today between the labs in NASA into industry, but I am wondering what strategies the administration has to widen and to expedite the sharing of new technology, especially from the labs in NASA into private industry and the private sector.

Do you have a strategic plan to expedite and broaden that transfer consistent of course with national security?

Mr. GIBBONS. I might just for a moment add that across the board the administration's concern is that these resources in the labs, NASA's, DOE, EPA and others, not only be directed toward fulfilling mission obligations and goals, but also to be much more accessible to people who can share, can more broadly share that information, expensively gained over the years. So that if you go to a typical Federal laboratory these days, whether it be Ames, EPA, or the others, you find there is an open gate now where there used to be a closed gate; that information moves, and that the utility of that information is greatly expanded because of this new sense of cooperation.

I would also like to add that, with your concern about, and I think properly placed, about the information system and its accessibility, there are two things I want to add to Secretary Brown's comments. One is that we feel that it is important to continue to make public investments in mechanisms for public use of this information infrastructure, whether it be for delivery of health care, government services, educational services and the like. So we are trying to help people on the demand side to be able to develop a means by which they can access and use that system.

And, finally, in every session I have been with the Vice President during the past year in which he has been concerned about the telecommunications policy, public policy, almost his first question every time is, I know we need to develop a competitive system, one that will be innovative, and we need policies that drive that, but we also need policies that assure access and equity in the use of this public good. So I can assure you we have that concern. It is not solved yet but we share your concern there.

Ms. LOFGREN. I would very much—oh, I am sorry. Dr. Goldin.

Mr. GOLDIN. With regard to NASA, we had a passive system which essentially said we put out these tech briefs and then people would have to read them, and the technology would be five years old or 10 years old. Technology is a time advantage on knowledge. If you do not get the technology out in parallel with the research, you lose it.

So we are going to a much more interactive system, and in fact I will use your district, or your area as a case in point. NASA-Ames is the center of excellence in NASA for information-intensive tech-

nologies, and we have a pilot project going there to develop an electronic access system to the whole database at NASA-Ames.

We are doing it with the business community in the area. We set up this business incubator, which is open to the whole area. We are also signing cooperative agreements with industry and when we send out requests for proposals, we encourage the proposing team to tell us how they might apply these technologies not just to opening up the space frontier but how they are going to disseminate it into the industry so America has a competitive edge.

So the answer is we are going from passive to proactive, real time data exchange using the high computer speeds we have to access the industrial base.

The CHAIRMAN. Time of the gentlelady has expired.

Ms. LOFGREN. Thank you very much.

The CHAIRMAN. Mr. Rohrabacher.

Mr. ROHRABACHER. Thank you very much, Mr. Chairman.

All this talk about all this reliance on the private sector, one wonders what the tax policies of this administration are about. The fact is, all I hear about is opposition to lowering the capital gains tax, and I have heard a lot in the last two years about taxing the rich, who are exactly the entrepreneurs and the investors who you, in your policies you are espousing today, are depending on. So I would hope the administration is a little more open-minded about not taxing every investment dollar away and putting it into the Federal account.

Mr. Goldin, I would share Mr. Roemer's concerns about the future of space if I looked at space as being, and the future of space as being totally a government endeavor. And the things you were describing were things that America could do, not just the government could do. Let me add that.

Mr. GOLDIN. Yes, I agree with that.

Mr. ROHRABACHER. Dramatically bringing down the cost of getting into space is a prerequisite of achieving the goals you stated early on. I take it that we cannot achieve those goals unless we do bring down the cost of getting into space. If we have to rely on the shuttle system, which costs hundreds of millions of dollars per flight, we are not going to achieve many of those goals; is that right?

Mr. GOLDIN. Absolutely. You cannot operate in space if you cannot get there.

Mr. ROHRABACHER. And NASA now recognizes that the SSTO potential is the most promising new means of bringing down the cost of getting into space; is that correct?

Mr. GOLDIN. Yes, sir.

Mr. ROHRABACHER. Dr. Gibbons, I understand that the cooperative agreement notice for the X-33, which is the phase of building exactly what Mr. Goldin is talking about, cheap access to space, but the X-33 ATT program is being held up in the White House at OMB because of concerns about mid term cost outlays for this long-term project of bringing down the cost of getting into space.

Does the administration plan to drag its feet because of these mid term costs in developing this new technology?

Mr. GIBBONS. Well, I am sorry, I can't go into the 1996 budget preparation this morning. If I did, I would probably be wrong in the numbers and it is a little premature.

But you must know that everything is being looked at very hard not only in terms of how we move from 1995 to 1996 but what are the outyear implications of major expenditures that may begin, and we just want to make sure we understand where they will take us as we look toward 1997, 1998, and 1999.

Mr. ROHRABACHER. Is your determination of outyears just five years from now or are you looking ahead to 2015, which is what this conference is all about today?

Mr. GIBBONS. The job in my shop is to look ahead to 2015 and 2020, when I might even still be here. But the job at OMB is typically to look at at least a five-year budget cycle. So there is always a constant kind of a dialogue, sometimes with considerable tension, between the priorities dictated by one year versus a five-year versus a 20-year look. And that is a reality.

Mr. ROHRABACHER. Dr. Gibbons, we can expect your office in and the White House will be then backing up Mr. Goldin's long-term commitment for the development of the SSTO technology; is that right?

Mr. GIBBONS. This will be a continuing dialogue and it is one of the reasons, Mr. Rohrabacher, I am very pleased that the Chairman held this early meeting of this committee. Because I think these are issues we need to be in dialogue about soonest.

Mr. ROHRABACHER. I hope this continuing dialogue means yes, but, obviously, you do not want to say that right now.

Mr. Brown, your chart suggested that there is $84 billion in private sector investment in research and development in this country. Would you believe if we limit or decreased the number of years of patent protection offered to American investors and inventors that would mean there might be less money committed in the private sector to research and development?

Secretary BROWN. I am not sure, Congressman, that the two are connected. I know how strongly you feel on this
issue.

Mr. ROHRABACHER. You do not see a connection between offering patent protection so that people can make money off their investment and the amount of money being invested?

Secretary BROWN. If you just take the 20-year term as an issue by itself and isolate it, you might be right. But in the context of what we are trying to do with patent and copyright protection, protection of intellectual property rights around the world, I am not sure that is the case.

I am very familiar with your point of view. You are very familiar with mine, I believe. But, as you know, there has been an exchange of communications between the administration and Senator Dole where we indicated that should your position prevail, the administration would not oppose it in the future.

Mr. ROHRABACHER. I will ask Dr. Gibbons about that.

Dr. Gibbons, the President, during the GATT negotiations, did make a commitment to Senator Dole that the administration will not oppose legislation that will correct what I and Senator Dole and other people see as a dramatic problem, which is the reduction,

which we believe will be the reduction in the term of patent protection for American investors and inventors. The President will not, he agreed not to oppose legislation correcting that, as we see it as a problem. Does the President's commitment still stand that he will not oppose that legislation which I introduced yesterday?

Mr. GIBBONS. As far as I know, that is correct, Mr. Rohrabacher. I would have to check, because I am not that intimately familiar with that part of the GATT dialogue. But I believe that is correct.

Mr. ROHRABACHER. Well, I would hope, then, that we do not see representatives of this administration on the Hill lobbying against legislation to correct this problem whereas the President made that agreement during the negotiations for the GATT implementation legislation.

Let me just end by saying with what I began with, and that is we have to talk about fundamentals. If fundamentals are not right, we are not going to achieve our potential in space or achieve our potential for technology, and that includes patent protection for American inventors and investors, and it includes making sure that we bring down the fundamental cost of doing business in space.

Thank you very much, Mr. Chairman.

The CHAIRMAN. Thank you, Mr. Rohrabacher.

Before going on to the next person I am counting people who are still in the room. If you are sticking around with the second round of questioning we told our witnesses we would be done by 12:30. When I count the number of people in the room, I am doubtful that we will get to a second round of questioning, and I don't want anybody to stick around with the idea that we are going to get there. The Chairman would like to ask a couple of questions at the end.

Mr. Calvert.

Mr. CALVERT. Thank you, Mr. Chairman. Primarily, this question is for Mr. Goldin, but I think maybe Secretary Brown would like to be included in this also.

I think we would agree that commercial and defense-related aviation is extremely important to this country not only to our economy but to our common defense. However, as we look into the future, new designs and innovations may be restricted by old and outdated wind tunnel technology. Obviously, industry, DOD and NASA's financial and technological participation is needed.

And I am wondering, is the administration prepared to make a sustained commitment to complete the national wind tunnel complex? Does that commitment envision a level of fiscal year 1996 funding similar to what was appropriated fiscal year 1995? If not, can you give us some insight as to the administration's plan or the schedule for the national wind tunnel complex related funding and the development of fiscal year 1996 and in the outyears?

Mr. GOLDIN. As I stated earlier, we have to make very tough, hard decisions because we cannot start new programs by putting new dollars on top of it. The wind tunnels fall into this category of real tough, hard decisions, and I will give you the factors behind the decision.

Factor one is, will the industry be willing to cost share at an appropriate level so this doesn't become just another government program? There is about $1 trillion worth of sales over the next two decades in long hold jet transports. At some time we have to have

some agreement with the industry about how we are going to cost share, because we are not going back to where we used to be where the government just built facilities and they became organic institutions.

Second is how much is it really going to cost and what are the other factors that enter in. There are huge environmental issues, huge power issues and water issues. Where is the right site to locate it?

We have about $75 million. We are contracting with an industry-led team led by Boeing over the next two years to answer these questions to come up with site selection with us so that we could have all the data so a decision could be made some time mid- to late 1996.

It would be very appropriate at that time to talk about it when we see what the industry will put in, how much it is going to cost, what the benefit to the industry is, and then we should proceed ahead. I think to debate the issue at this point in time is premature.

Mr. CALVERT. Thank you.

The CHAIRMAN. Thank you, Mr. Calvert.

The distinguished Chairwoman of the Technology Subcommittee, Ms. Morella of Maryland.

Mrs. MORELLA. Thank you, Mr. Chairman.

Again, I reiterate what has been said about the fact that this is a great way to start this 104th Congress by having the important people whose issues we will be addressing here in Congress come before us. So I compliment you on the streamlined way it is done to begin with.

I also want to thank the witnesses. I very much appreciate the succinctness of the testimony you gave, recognizing from your written remarks that you had much more that you wanted to embellish on and the fact that you are giving us pretty much of an overview. We recognize the major challenges that we will have before us.

I was also troubled by The Washington Post series. I read it. I cut it out and shared it with staff. It troubled me to think that we have personnel problems, where Sam Browder from NIH in my district decides that he is going to leave, and he talks about regulations and impediments that he faces as a public servant dedicated to research and the subsequent articles, and the basic research, what our dilemma is.

Dr. Gibbons mentioned something about the important point of interrelationships, and I think that that is something that you all are aware of and must continue to be aware of in the work you do and the recommendations that you make, and we as a committee must be, too. We are talking about, for instance, not only education but the whole concept of basic science.

I had the opportunity, Dr. Lane, to succeed you in Antarctica, so I came back with a great deal of respect for the program of NSF there and the support staff and the fact that it relates to EPA with the ozone hole and NOAA and the whole continuation and going from basic science to applied science to technology. And I want you to know, Secretary Brown, that I will be inviting all Members of this committee and particularly Congressman Hastings to go to

NIST to see what happens there in terms of how important it is to our technological development and competitiveness.

So I just think we must continue to stress the whole concept of do we have too many scientists. That was another part underlying that article. I would be interested in your responses to all that.

But, basically, I want to not only emphasize the concept of interrelationships but pick up on the idea that the Members of this committee are committed to building our Nation's economic strength, and all of us on this committee have a number of small businesses that have emerging technologies in their districts, too.

Many of the programs under Commerce have been mentioned, and you also mentioned the environmental technologies, too. But I wanted to point out again that we will be looking—this committee will be looking at the ATP program and the Manufacturing Extension Partnerships, reviewing them, and all of the programs within our jurisdiction to determine their success and how we can best use our scarce resources. I think you know that has been something on the top of the agenda.

Specifically with regard to the ATP and the MEP perhaps, maybe Secretary Brown should respond. What kind of response are you getting from the private sector? Is it vital? Is it tepid? Is it we don't know yet; it is too early to look at? By that I mean the ATP program versus other technology programs.

Then I will ask you to follow up with the MEP program as you look to 2015. Where should that be?

Secretary BROWN. I would say universally and overwhelmingly positive.

If anything demonstrates that it is the material that Congressman Brown asked to be put in the record when he first came in. And that is the statement on R&D policy and competitiveness issued by the Council of Competitiveness, an organization that is incredible.

Just if you look at the stature of the people involved in it, who basically have said everything they can say to be supportive of the direction that we have taken both in terms of our advanced technology program for the reasons I have tried to articulate earlier but just as importantly our manufacturing extension program, which is much like the old agricultural Extension Service of the early part of the century which is the key to our preeminence in agriculture. We didn't get there by accident but because it was a government private sector partnership.

That is the same way we are going to keep our preeminence in technological innovation, in productivity and competitiveness, in the future, through programs like our manufacturing extension program.

We have had great private sector support. We have had to go out and earn it. There was some skepticism—I know there still is—which we are prepared to take on in a very a frontal way because we think these programs are working. We have a plan, a strategy. We are implementing it, and it is working. We know we have an obligation to demonstrate that to the Congress and are prepared to do that.

Mrs. MORELLA. Could I ask whether or not other countries have such manufacturing extension partnerships?

Secretary BROWN. Japan does. As you know, Japan is one of our biggest, most important global competitors. Germany has a program.

If we are going to stay on the cutting edge we need to be willing to make some investment in our future, and we know that is what this debate and discussion is about: How do you best spend limited resources, get the most bang for the buck? How do you assure that you are not penny wise and pound foolish when you look to the future of 2015 and beyond?

The CHAIRMAN. The time has expired.

Mr. Cramer of Alabama. I don't believe he is here.

Mr. Tiahrt of Kansas.

Mr. TIAHRT. Thank you, Mr. Chairman.

I appreciate this opportunity to get my feet wet for the new Congress here, and I appreciate the administration coming and telling us how we are going to fulfill the vision for the future not only for this Congress but for the future of our children.

I heard Dr. Gibbons refer to not eating the seed corn, and I think our government has forced a political consumption of the seed corn by mismanagement of the some programs, and I go to the supercollider. We had escalating costs, we had lengthy delays and numerous redesigns, and we don't know how long delayed the knowledge that we will have about quarks or the strong force. And perhaps that could have contributed to our next propulsion system, but now it has died and been postponed or delayed at best.

Can the government effectively manage a large program like this? What is the plan that we don't force a political consumption of our seed corn?

I would like to follow with Mr. Goldin and the Space Station. Already I hear people nibbling at the cob wanting to get at that seed corn. What is our plan so we can effectively run government programs and avoid these overruns?

Mr. GIBBONS. Your point is well taken. I think the SSC is maybe a special case, but sometimes special cases have special lessons with them.

As you recall, on the superconducting supercollider it was begun in the midst of a pretty fierce Cold War in which the prior two administrations chose to make this a national program, not an international program, and that was one of the, as it were, seeds of its ultimate demise. Its expense, its size, the complexity fully justified it being an international cost-shared program, and it was too little too late in trying to turn it in that direction when we began two years ago on that. And Congress, in its wisdom in trying to find ways to trim the budget, took out the SSC.

The U.S. work in high energy physics continues, however. We have upgraded the FERMI lab injector. We are building a factory at Stamford. We will be at the forefront for another decade and during that time are attempting to become a part of the large international consortium on the large hedron collider which will probably be built in Switzerland. In other words, we feel that in very large, highly expensive endeavors that these are inherently international in flavor, and we should move in that direction, and that is what we are doing.

Mr. GOLDIN. With regard to the Space Station, the single most important thing we could do is to not change one nickel, not one schedule, not one milestone. We have had 10 years of paper. 1994 was an historic year. We built 26.5 thousand pounds of hardware. We are measuring our progress not by the number of reports, but we have a curve that plots number of pounds of hardware per year. We actually beat that by 1.5 thousand pounds last year.

It comes back to the question that your colleague from Florida asked. What do we have to do?

We have to stop asking for changes and redesigns. If there is one more request for redesign I will recommend the cancellation of the Space Station. We will destroy the ability of this country to do it. We don't want to change one thing. We want to proceed as is.

Mr. TIAHRT. I know that the Space Station has gone through downsizing. We have done some re-engineering. What system have you put in place that you have confidence in that is going to make sure that we get through this without a large cost overrun?

Mr. GOLDIN. We took the government out of the process, and we got a single prime contractor that is competent. And we are listening to that prime contractor, and we are reducing the number of government employees in the management of the system. That is already complete, and we have a very detailed set of milestones, and we march to the milestones. We are managing to schedule. We are not managing to paper.

Mr. TIAHRT. I hope that you document these precesses, this methodology and that we make them available to other agencies because I do think that is a successful program, and it will keep us from politically consuming the seed corn.

Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Goldin, you may want to tell Mr. Tiahrt who that prime contractor is.

Mr. GOLDIN. It is Boeing.

The CHAIRMAN. The Chair next recognizes Mr. Ehlers, the gentleman from Michigan.

Mr. EHLERS. Thank you, Mr. Chairman.

I join my colleagues in heaping accolades on you for conducting this hearing. I have always been very future oriented with very long time-planning horizons, and I think it is essential that we look at the questions that you laid out in the charter. My preference would be to look 30 years down the pike instead of just 20.

But I am also concerned by what I perceive to be lip service on the part of some of the people we have heard from this morning, lip service to basic research, because I think if you are talking 20 years in the future the most important issue that we have to address is basic research.

I recognize there is some validity to Dr. Gibbons' comment today there is not much distinction between applied and basic. I would quibble with that. I think there is a serious distinction there. But I am really concerned about the line of questioning as well, indicating more concern about the short term than the long term.

I appreciate, Dr. Gibbons, you are reminding me of that delightful quote that the night before you are hanging certainly focuses your mind. I have never been in danger of hanging, but I can as-

sure you that the night before an election also focuses your mind very well.

I think too much attention in Congress has been focusing on the immediate term because we face so many immediate problems. But, as you said, the job market of the future, particularly 30 years from now, not just in science and technology but the job market for the Nation, depends on the basic research we do today. I can give numerous examples to the panel and to my colleagues to support that statement.

And yet I don't see our Nation having the commitment to basic research that we had before. I see that faltering. I am particularly disturbed at what has happened in the past few years.

And I don't engage in Senate bashing, but I will use an example of the Senate Appropriations Committee with their strong emphasis on strategic research. If you read their report on the NSF budget of last year, a statement such as not less than 60 percent of the agency's annual research activity should be strategic in nature. I think that has a real danger of cutting into important funding for basic research.

I am very concerned with the new Office of Interdisciplinary Opportunities in NSF. It may in fact be a very good idea, but the money for it is pulling—$30 million, as I understand—away from existing basic research programs in math and various science programs, I think that is a dangerous trend, and I am worried about an Appropriations Committee which by virtue of its report and the money it allocates is setting science policy.

Mr. Chairman, I think what you are trying to get at with this hearing is to establish a coherent congressional science policy as it relates to basic research, and I commend you for that because we desperately have to do that within this committee and its Senate counterpart and not simply let it be established through the appropriations process.

Having been on my soapbox for a few moments I would like to just direct some questions to Dr. Lane, in particular, of the National Science Foundation and Dr. Gibbons.

I would be interested in your reactions to my comment, but specifically I am very concerned about what you see that can be done to strengthen the basic research component of this nation in terms of Federal funding for it.

I am very serious about my concern about the direction we have been going in the last two decades. Ms. Browner will need better research for her agency to do the risk assessment that we are talking about demanding from them. We will need better research in many areas to fund or to provide the base for the applied technology that we will develop in the future through NIST and other agencies.

To paraphrase Einstein, he commented that he only saw further because he stood on the shoulders of the people who came before him. That is the model that still continues to work in the scientific arena.

Dr. Gibbons, Dr. Lane, I would appreciate your responses and your perspective on that issue.

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Mr. GIBBONS. Let me just start, sir. I very much appreciate your comments, and having spent a significant portion of my professional life in basic research I very much appreciate them.

You may be familiar with the work we did last year that resulted in a publication released by the President called Science in the National Interest in which we tried to underscore not only the interconnectedness of basic science all the way to technology and their interplay but also we raised by way of a question an issue that Mr. Brown referred to earlier this morning about how much is enough? How much is appropriate for us to spend? With our kind of society and our kind of economy, what is the appropriate amount for us to be investing in basic research and in other areas of science and technology?

I don't think the answer is here yet. I do know that the National Science Board and now the National Academy of Sciences are wrestling with this at our invitation. We posited a 3 percent number as drawn from other national economies. We are not sure that is the right number. And, as Mr. Brown points out, we are not going to make it. We are already well below that number. I think this coming year is the ideal time to address the question.

The administration over the past two years, while we have been working with a zero sum game, no increase in current dollars in so-called discretionary programs, we have managed to increase the budgets of our basic science, and it has held all the way to the President's decision. It has held a priority even to the point of taking money away from other activities.

The CHAIRMAN. The time of the gentleman has expired. I will allow Dr. Lane to respond to the question.

Mr. EHLERS. May I give a one-sentence clarification of my question? That is, the National Science Foundation has always been the traditional bastion of basic research, and I would like your response to the directives you are getting from Congress to broaden that into applied areas.

Mr. LANE. Thank you, Mr. Chairman.

Mr. Ehlers, I appreciate your question. This multi-disciplinary fund is I think in the math and physical sciences directorate and really is to support basic research. The idea is to try to get at certain areas of interface, like physics and biology, some areas that haven't been handled as well as they might by our traditional structure .

I would emphasize that we take high risk on large projects. We support LIGO where we expect to observe for the first time gravitational waves from calamitous events in the universe, Gemini, fundamental efforts to understand nature.

The language of the Senate appropriation subcommittee that you referred to did get my attention. It arrived about the same time I did. As I began to understand what the message was there my conclusion was that the emphasis at NSF was expected to continue to be on basic research, the very highest quality basic research, but that there is basic research that can be identified as important to certain so-called strategic areas, and we were asked to pay attention to those.

So our commitment is to continue to fund the most outstanding basic science across the board at the frontiers of knowledge, and in

many cases that will be science that applies to one or another larger issue.

I know Ms. Browner would like to add something.

The CHAIRMAN. Quickly.

Ms. BROWNER. I have made a public commitment on behalf of the research and development budget at EPA that we will increase from 35 percent to 50 percent the funds we apply to basic research. We think it is fundamental if we are to move beyond a crisis-by-crisis, pollutant-by-pollutant approach to public health protection.

Mr. EHLERS. Thank you.

The CHAIRMAN. Thank you, Mr. Ehlers.

Mr. Stockman of Texas.

Mr. STOCKMAN. I want to thank the Chairman, of course. He put together I think a great panel, and thank you for taking your time out.

I have to say that I am from Johnson Space Center—that is in my district—and I have a few questions regarding that. Mr. Goldin, my wife personally worked on those designs several times, and I didn't know we had so many rocket scientists here directing you, telling you how to build it, but I am finding out.

I think you are correct in your assumption. If they change or alter it, it is gone. Those folks there—and I welcome my colleagues to visit those people that have worked so hard. I am not against cutting. I was the one that introduced cutting committee staff by 25 percent. I believe, though, that as an investor you look at things.

And Dr. Gibbons pointed to this, that we get a 50 percent return on our investment. When you are cutting spending you don't cut your portfolios in stocks to cut spending. You look for other areas where you are spending. I would suggest that science and technology is an area of investment, not an expense.

I would like to know, Mr. Goldin—we are talking about the future, 2015. Are the Russians going to be our partners in 2015?

Mr. GOLDIN. I don't know. But we have to find out by working with them and trying to understand. We spent 50 years pointing weapons across the ocean, and I designed some of them. The time has come to try and see if we can work with the Russians, work side by side.

We have a specific project. We are going to see if we can successfully do that. If that works then perhaps we could do even bolder things with the Russians. But I would say let's crawl before we walk and walk before we run and run before we trot.

I think we have a very sound program. In fact, I would like to tell you that in the one year that we have been working with the Russians I have seen some incredible things happening. We are learning a lot. The Russians know a lot. They are learning from us, and I think we have a much, much better space program.

Mr. STOCKMAN. Do you believe that Russia is going to remain a democracy in the next five years?

Mr. GOLDIN. If I knew I would be a very wealthy man.

Mr. STOCKMAN. I am concerned that we are putting $400 million in a basket which I feel may be wobbly at best.

In your prepared statement you said 1,500 employees were cut from NASA. I can attest that that is true. In fact, that is one rea-

son I am here. You also mentioned 2,500 more to go. Could you tell me specifically, do you know the numbers for Johnson Space Center?

Mr. GOLDIN. No, I don't. I could supply it.

[The information follows:]

Material requested for the record on page 106, line 2445 by Cong. Stockman during the January 6, 1995, hearing at which Administrator Goldin testified.

During the period from September 1992 through December 1994, NASA has experienced a net loss of approximately 1,800 civil servants - a 7.4% reduction. During that same period the Johnson Space Center (JSC) which includes responsibility for Space Station Program Management, has had a net loss of 125 civil servants - a 3.4% reduction. There are currently 3,506 civil servants at JSC.

In our efforts to further streamline, we are conducting a workforce review which we expect to complete in mid summer 1995. The results of this review will guide any further program reductions.

Mr. GOLDIN. I want to come back and say we have got to work together, and if we protect jobs at any center or we protect jobs at any contractor we are stealing from our children.

I come from an industry where in about three or four months I had to lay off about 1,500 people. I developed a stomach problem from that, but I did what had to be done.

If we are going to do what we promised the American public, we cannot protect jobs at any NASA center, and we cannot protect jobs at any contractor. We are going to need your support to do some very rough things.

If we want to satisfy what Mr. Roemer has brought up we have to decide what are the priorities for NASA, how much budget are we going to get, and how do we take things out of the budget to pay for new things. I know this is tough love, but this is the only way we are going to have a future in this country.

Mr. STOCKTON. I hope we look to Americans first before we do the Russians.

Mr. BROWN. Would the gentleman yield to me just briefly?

Mr. STOCKTON. Yes.

Mr. BROWN. Many Members of the committee share the concern about the Russian situation, one of the foremost being Mr. Sensenbrenner who visited Moscow in October and made a thorough check on the situation with the Russians as well as visiting with the Europeans and has written a report on his recommendations here. I thought it was good enough so that I recommend it be distributed to all the Members, but I thought you should know that others share your concern.

Mr. GOLDIN. I would like to add one other point to deal with the issue you brought up.

We, at the suggestion of this Congress, at the suggestion of Mr. Sensenbrenner, have set up an alternate program in the event there are problems in Russia, that they are not on the critical path of the Space Station so that we can proceed. And I do want to say that we are getting tremendous value for our money.

February 2nd, we are going to launch a space shuttle up to the Russian Space Station and come within 10 meters. That is within 14 months of the time we agreed to do it.

In June, we are going to rendezvous and dock. We will get a three- to four-year lead on critical functions. That $400 million is worth every nickel, and we could not get it any other way. So it is a wonderful investment, and I think we have done the right thing.

Mr. ROEMER. Would the gentleman yield?

Mr. STOCKMAN. Let me say that I am not against Russians because we have a Russian exchange student in our home, but I would kind of like to keep Americans first. I yield.

Mr. ROEMER. I have a suggestion. You could ask Mr. Goldin for one more redesign to take it away from the Russians if you wanted to.

The CHAIRMAN. The time of the gentleman has expired.

Mr. Ward of Kentucky.

Mr. WARD. I am a new freshman. I have so many questions I don't think 56 minutes would contain them, so I think I will just keep on listening.

The CHAIRMAN. We thank the gentleman.

We go next to Mrs. Seastrand of California. She is not here.

Ms. Jackson Lee of Texas.

Ms. JACKSON LEE. Mr. Chairman, thank you very much. And I think all of us are gratified by the vision that we are offering for this time as we move to the 21st century.

Let me indicate that I am a very vigorous neighbor of my colleague, Mr. Stockman. I am from Texas in the 18th Congressional district, which as I campaigned it was interesting to be in churches in the inner city and find them claiming with all due respect and admiration of the Johnson Space Center and all that it has done. So I come with a special burden to be able to really hone in on where we are going for the 21st century and how that vision will be articulated.

I am grateful for your presence this morning.

Along with other items in the paper I noted one item that struck me which was the loss of another teenager on the sidewalks of an American high school by violence. Someone would say why is that relevant for a committee such as this? But I think it speaks to my district and districts all over America that have many of our citizens living in the inner city and what we are actually talking about as we talk of a vision at the same time when we harshly talk about cutting and slashing a budget that is already very slim.

Secretary Brown, if you would help me understand as we look at the Advanced Technology Program and this dialogue about the private sector and the role that government must play—I think realistically if we talk about advancing America and creation of jobs, we fully realize that business persons do well to stay in business by taking limited risk, so when there are times to look at whether you go to the next step, albeit they might want to do so, they might have a second thought or two.

Would you help me understand, then, ATP and the real value that it gives to allow business go the extra mile? Sometimes we like to look lovingly and nostalgically on history—the Wright brothers and inventing of the airplane, when the dollars were far less; the invention of the light bulb, the dollars were far less. How does ATP help businesses take the extra mile? And I would like to get to Mr. Goldin and Ms. Browner.

I will be asking you, Mr. Goldin, to respond to me very directly on how we expect to get the new rocket vehicle with the cuts that we are looking at under the Contract With America that has been put before us.

Ms. Browner, I am very interested in what we did with lead paint and some other environmental issues. I would like you to tell me what is on the agenda and what kinds of costs those will entail as we look towards the 21st century.

Mr. Brown, I would appreciate if you would help me with that, including your dialogue, if you would, your assistance or work with minority businesses and how that generates into employment.

Secretary BROWN. First, as you know, I share your concern about young people in America. It seems to me the key to their future is inextricably related to how we fare in a very tough, globally competitive environment, how we assure that we can create economic growth and the jobs that go with that growth.

It seems to me increasingly clear that the world has changed dramatically, that global competition is much different than it was 20, 10 or even five years ago; that the American private sector a few years ago was investing 6, 7, 8 percent into research and development. Because of global competition, some are investing nothing anymore; or some are investing 1 percent, or a half of 1 percent, and it is invested in things that can be turned around in two or three months, or at the most 18 months, and that can be immediately commercialized and profitable.

This hearing is focused on 2015, how we get there and how we create opportunities for the future. I don't believe that there is any way that we can effectively do that without the kinds of partnership that I have described.

Now, there are options. You make choices as far as how you expend resources, and you have to make judgments as to how you get the most from those resources. Some suggest a change in tax policy is the best way. There are others who suggest a more targeted approach is the best way. There are others who suggest we need to take a look at what our competition is doing and how we make sure that we are successful in that increasingly competitive global economy.

That is the kind of assessment we are making every day. It is the kind of assessment we made two years ago when the President made some very courageous budget decisions which in fact took a giant step towards reducing our deficit. I happen to believe those decisions are the principal reason why the fundamentals of our economy are now in good shape, why consumer and business confidence is up, we have an economy that created almost 6 billion new jobs in two years, it is why we are moving in the right direction. And it appears that this is going to be sustained recovery.

The most important thing we can do for the young people of America, with the exception of making sure they are trained for the jobs of the 21st century, is to make sure that we have a growing economy that can accommodate their needs and aspirations and that is what the ATP program contributes to.

You asked me a question about minority business, if I could take one second, Mr. Chairman. We obviously are focusing very much on making sure that this economic prosperity that we want to be sustained includes all Americans, that in fact this rising tide does really lift all boats and maybe helps to provide boats for those without them. Many of those people are in inner-city communities and distressed rural communities.

So we are working very hard, whether it is on the trade missions that I take around the world, whether it is how we build our Minority Business Development Agency, whether we include minorities and small business owners in all our programs as a way of reaching out to those who in the past have not been included in periods of economic renewal.

The CHAIRMAN. The time of the gentlelady has expired.

Ms. JACKSON LEE. Mr. Chairman, would you allow Mr. Goldin to answer my question on the rocket?

The CHAIRMAN. I am going to suggest that maybe Mr. Goldin and Ms. Browner could answer your questions in writing. We have other people here, and we did allow an extended time for Secretary

Brown to answer as well. So if we could ask Mr. Goldin and Ms. Browner to reply to the gentlelady from Texas in writing.

Ms. JACKSON LEE. Those are important issues in my district. I would appreciate it if you would respond. Thank you.

[The information follows:]

Response to a written question submitted by Congresswoman Lee resulting from the January 6, 1995, hearing at which Administrator Goldin testified.

QUESTION:

Please provide specifics on how a new launch vehicle will be funded and built under the present budgetary climate which calls for a balanced budget by 2002.

ANSWER:

NASA cannot afford not to proceed with a program to revolutionize space launch capabilities. The Agency is currently spending approximately $4 billion per year on launch costs, and cannot continue to do so as the total budget shrinks. We must invest now in technologies to dramatically reduce the cost and increase the reliability and operability of space launchers by early in the next decade. If we do not make these investments, we will not be able to afford to do all of the important science, aeronautics and technology work that is the ultimate purpose of the agency.

The President's budget provides funding to support a White House decision in 1996 on whether or not to proceed with the development and test of an experimental flight vehicle. This decision will be based on detailed technical criteria and confidence in our ability to demonstrate the dramatic reductions in cost. Funding beyond the 1996 decision will be based on program requirements but will also consider the impact of National Performance Review Phase II activities.

The U.S. Environmental Protection Agency's Lead-Based Paint Abatement Program

The goal of the U.S. Environmental Protection Agency's (EPA) lead-based paint program is to help in significantly reducing the incidence of blood lead levels above 10 μg/dl in children by fostering and supporting federal, state, local and private programs and projects aimed at reducing childhood lead exposures from lead-based paint in housing. These activities include the development of appropriate technology and the means to implement it.

These goals are being met by the following types of activities:

1) Eliminating or reducing the residuals of past lead sources

With the phase down of leaded gasoline in the 1980's and the attention being given to lead-based paint in residences, the EPA is addressing the two most significant sources of lead exposure for children.

2) Addressing any serious current uses

EPA has been addressing current uses of lead through various measures, including limits on manufacturing emissions and controls or restrictions on current products such as lead fishing sinkers and lead-containing brass faucets.

3) Vigorously setting and enforcing current standards

EPA has established standards for lead in water under the Safe Drinking Water Act and has a National Ambient Air Quality Standard (NAAQS) for lead in air, as well as other standards for exposure to lead through other sources. In 1991, the Agency announced a nationwide multi-media enforcement initiative which highlighted EPA's strong enforcement commitment. The Office of Air Quality Planning and Standards has also made strong progress in enforcing NAAQS standards.

4) Establishing a system for preventing undesirable new uses from entering the market

Through the use of a Significant New Use Rule under the Toxic Substances Control Act (currently under development), EPA will be notified of new uses of lead before they enter the market.

5) Promoting public education of lead hazards

The National Lead Information Center, maintained by EPA and funded by EPA, the U.S. Department of Health and Human Services, the U.S. Department of Housing and Urban Development (HUD), and the U.S. Department of Defense, provides information from many federal agencies to the public. Other program specific clearinghouses, such as the Safe Drinking Water Hotline, provide additional media-specific information on agency programs.

6) Promoting research to better identify, assess and abate risks from lead exposure

The agency has an active research program in place to develop and evaluate safe, cost-effective abatement techniques.

7) Assisting state and local governments

Through a variety of committees and task forces, the agency reaches out to other federal, state and local agencies to develop appropriate infrastructures and methods to reduce lead exposures.

Title X

On October 28, 1992, the Housing and Community Development Act of 1992 (P.L. 102-550), which includes Title X, "The Residential Lead-Based Paint Hazard Reduction Act of 1992," was signed into law. Title X provides for a comprehensive national approach to dealing with lead-based paint in the nation's housing stock. The focus of lead-based paint activities has changed the philosophy from total abatement to a program of abatement and in-place management of priority hazards (including soil).

Title X forms the cornerstone of EPA's activities on lead-based paint. EPA is currently involved in implementing the mandates under Title X. These activities range from developing information pamphlets, funding and maintaining a lead hotline, to developing regulations that require the training and certification of abatement workers. The following is a short summary of some of the activities EPA is currently engaged in to address the risks of lead.

Public Education

EPA has developed a comprehensive public education campaign to raise the national awareness of lead hazards. As a key component of this campaign, EPA and other federal agencies have put in place a National Lead Hotline (1-800-LEAD-FYI) and the National Lead Information Clearinghouse (1-800-424-LEAD).

Abatement Training

Pursuant to section 402(a) of Title X, EPA is developing regulations to ensure that individuals engaged in lead-based paint activities (e.g. abatement, inspection etc.) are trained, training programs are accredited and contractors are certified. The regulation will also establish standards for conducting these activities.

EPA is also developing a model state program for states to adopt that seek to administer and enforce these regulations. In states that do not adopt the program, EPA will be required to administer this regulation. EPA proposed this regulation on September 15, 1994, and after a review of public comments expects to finalize this rule by October 1995.

EPA has also been authorized to provide grants to states to develop and carry out authorized programs. In Fiscal Year 1994, $11.2 million was awarded to 49 states, 18 Indian Tribes and the District of Columbia. In Fiscal Year 1995, EPA expects to make $12.5 million available to the states.

EPA is providing support for a national network of Regional Lead Training Centers to provide quality training on lead-based paint abatement and removal. EPA has also developed model course materials to be used by the centers as well as private training providers.

Renovation and Remodelling

Under section 402(c)(2) of Title X, EPA is currently conducting a study on the hazard potential of renovation and remodelling activities. This two-part study is composed of both environmental field sampling and a blood lead study of renovation and remodelling workers. This study is expected to be complete by April 1995. EPA will evaluate the findings of the above mentioned study to determine if any category of renovation or remodelling workers pose a risk to themselves or to others. EPA will then develop a regulation that would require that any worker who poses such a hazard must be properly trained and certified.

In an effort to address the risks of renovation and remodelling activities in the short term, EPA has also promulgated guidelines for the conduct of renovation and remodelling activities which may create a risk of exposure to dangerous levels of lead.

Lead Hazard Pamphlet

Title X also directed EPA to publish a lead hazard information pamphlet. The final pamphlet is currently being revised and will be available by June 1995. EPA proposed a

regulation on March 3, 1994, that requires renovation contractors to furnish customers with copies of the EPA pamphlet prior to beginning work. This regulation will be finalized by the fall of 1995.

Lead Disclosure

EPA is also working to make people aware of lead hazards in property they may rent or purchase. Under section 1018 of Title X EPA and HUD are jointly developing a rule that would require: purchasers and lessees receive EPA's lead pamphlet; sellers and lessors disclose all known lead hazards to purchasers and lessees; purchasers have a 10-day period for inspection for lead-based paint hazards; and sales contracts contain a lead warning statement. This rule was proposed in November 2, 1994, and is expected to be final by the end of 1995.

Lead-Related Research

EPA is conducting a wide range of research efforts designed to improve lead detection and removal techniques. The Agency is conducting or sponsoring three studies of low-cost lead paint abatement approaches. The most extensive of these is an effort to assess the short- and long-term changes in lead in children's blood and in house dust associated with three levels of low-cost exposure reduction interventions in lead-based paint housing. A report on this study is expected in 1997. A study of practical abatement approaches is also being conducted, including an assessment of the short-and long-term changes in lead in children's blood and in house dust associated with current exposure reduction interventions in lead painted houses. A report on this study is expected in 1995.

EPA is also conducting a field evaluation study of portable technologies for detecting lead in paint. A report on study results is expected to be published in February 1995. EPA has also carried out an assessment of existing studies of the efficacy of lead-based paint abatement.

Identifying Lead Hazards

EPA is developing standards for dangerous levels of lead in paint, soil and dust. Section 403 of Title X required EPA to promulgate regulations that identify lead-based paint hazards, lead-contaminated dust and lead-contaminated soil. The Agency issued guidelines on this subject in July 1994 and expects to propose a regulation in 1996.

Other Lead Activities

EPA is also heading up an Environmental Justice pilot effort with the Centers for Disease Control and Prevention (CDC), HUD, and the Department of Labor to reduce lead exposure from lead-based paint abatement and encourage community involvement.

In addition to these specific programs, EPA is actively working with other federal agencies, including HUD, the Occupational Safety and Health Administration, the Consumer Products Safety Commission, and CDC to develop innovative and effective programs to address lead exposure and lead poisoning.

Cost of Lead Paint Abatement

It is difficult to estimate with any accuracy the costs of a particular lead-based paint abatement project. Many factors contribute to the final cost of a project from the abatement technique chosen to the amount of hazardous lead containing debris the project generates. The HUD Lead-Based Paint Abatement Demonstration Project estimated that an abatement would cost between $2,908 and $7,703. HUD went on to say that "... many units will cost less and some with larger amounts of lead-based paint will cost more to abate."

The training and certification regulations that EPA is proposing are expected to increase these costs somewhat, but these costs are offset by the increased effectiveness and safety of abatements conducted by trained workers.

The CHAIRMAN. Mr. Hilleary.

Mr. HILLEARY. Thank you, Mr. Chairman. I am one of these freshmen. This is my first hearing, and thank you for assembling such a panel as this, all stars. This is going to be a pleasant experience on the Science Committee if this is the standard we can become accustomed to.

Mr. Goldin, we met once before. You spoke at a commencement of the University of Tennessee Space Institute, gave a great commencement speech; and I had a lot of people come to me that said they were going to remember that one as one of the best ones they had ever heard, and it was very fine.

You mentioned that it might be premature to talk about the national wind tunnel complex, where it is going to go, maybe whether or not it is going to be in existence. What is your opinion on where we are, status wise, with wind tunnel technology? Do you feel we have lost an edge over the last several years to overseas, and has that resulted in—how many jobs possibly moving overseas because of that?

Mr. GOLDIN. America clearly has lost an edge that we had in wind tunnels. Our wind tunnels are not as productive as those in Europe, and in some cases our wind tunnels don't have the same operating performance as those in Europe. We have to deal with this.

The problem that we have is, there is this constant squeeze on the budget and we have to prioritize. The issue facing our industry is, can we come up with an effective approach by utilizing computational fluid dynamics such as, in essence, flying an airplane on a computer and backing that up with a set of wind tunnel testing for the most part in this country, but perhaps a little bit of it overseas.

My sense is, we will probably want to look more aggressively at building tunnels, but it comes back to the partnership issue with industry, that I don't think at this point in the game the government can unilaterally build a wind tunnel without having some real firm cooperative agreements with the industry. That is really why I was hedging, but my tummy tells me we need to do something.

Mr. HILLEARY. My tummy, as well as many of my constituents', says we do also.

Is it not possible—I know many jobs have been lost because of losing our edge. Is this an area that possibly might pay for itself? I know it is a tough budget time, but between now and the year 2002, when we are all talking about balancing the budget, could this not pay for itself, actually bring back high-paying jobs and the resulting income tax revenue to the Federal Government?

Mr. GOLDIN. It could, and that is one of the reasons I am saying, let's do something right. We have an opportunity here to work with the industry to collect the data; we have it fully funded, $75 million that we are funding the industry to understand exactly the factors you brought up. So we are not just going to come forward with a proposal saying, this is how much it will cost; we will say, this is what the investment is going to do—no deposit, no return—we would like to work with you over the next two years to collectively understand what is the right thing for America to do. And this gets into the category of how we are going to have to work with the

Congress to make these very hard decisions, because if we do that, we may not do some things in science.

You know, when you have a declining budget, you have to make these hard decisions, but we will have the data and will be happy to give you briefings as we go along, knowing your interest.

Mr. HILLEARY. I—in the campaign, I ran as a fiscal conservative and went to these folks at Arnold Engineering Development Center and said, I want to support this, but you have to convince me this is economically sound, budgetarily sound, that this would create jobs and enhance revenues to the Federal Government and not be a budget buster; and they convinced me of it. I will try hard to convince folks here of it.

I appreciate your remarks and yield back.

Ms. JACKSON LEE. Would the gentleman yield?

I wanted Mr. Goldin to clarify my inquiry. I happen to believe that cuts are not realistic. I think effective management and efficiency is the way we should go. In your written response, I would like preciseness on what the effect of cuts ultimately, as we go to the next budget year, will be on this new rocket vehicle that we are talking about. I want a detailing of that, because I don't think we are being realistic if we are talking about a vision for the 21st century, and we are also talking about undercutting the very girdle, if you will, of how we are going to get there.

Ms. Browner as well. I would appreciate the cost analysis. Thank you.

The CHAIRMAN. The time of the gentleman has expired.

The gentleman from California, Mr. Baker.

Mr. BAKER. Thank you, Mr. Chairman.

Let me echo the thoughts on this fine panel. I hope we can meet quarterly so that, as we talk about 20-year plans, we will act like a business and review the first steps in that journey of a thousand miles to make sure we are pointing in the right direction. I don't see any acrimony or any difference, because we are all fiscal conservatives. The gentleman said he ran as a fiscal conservative. That is because he is one, and we all are going to be because business has downsized and so will government.

Part of the debate in the last election was the impracticality of the laws that Congress has passed, made even worse by the departments and the agencies. The debate between applied science and basic science was carried over into politics saying, we don't know where you are going or how you are getting there, but you are overregulating us in our business and in our homes, and you are overtaxing us.

In that focus, Ms. Browner, I have to ask a strictly one-issue question. The Clean Air Act of 1977 required States to submit ozone and carbon monoxide plans. California submitted a plan on time, and we are perhaps the only State that did; and we are, of course, the most affected, but we are one of the few States that met the deadline. However, it is not approvable in time to forestall court implementation of one of the environmental groups, and therefore imposing a Federal implementation plan, which Secretary Pena has described in a letter to you, and I quote,.

I "believe that the plan will have an extreme and unacceptable level of impact on the economy, employment and the free flow of

commerce in the south coast of California area. We are also concerned that the proposals could have an adverse effect on transportation safety, exceed the legal authority of the EPA, intrude into areas which are under the jurisdiction of the Department of Transportation and in some cases could be violations of international agreements".

What are the chances of the EPA approving the State of California's implementation plan, even on a provisional basis, prior to the upcoming court-ordered deadline, and are the requirements under the FIP, the Federal Implementation Plan, in fact attainable with today's technology; and if so, how much will it cost California to meet these requirements?

We were hit once with defense spending cutbacks, once with base closings, once with an aerospace industry meltdown because United and American can no longer afford to buy new planes. California is in rocky economic shape. Along come the environmental groups to dot all the I's and cross all the T's, and they want by February 15th us to literally go back to pushcarts in delivering goods and services in California.

Can you not at the EPA level approve California's plan and continue working with the States to attain these ozone and carbon monoxide standards?

Ms. BROWNER. Mr. Baker, my position has always been that we would like nothing better than to work with the State of California to achieve the goals of the Clean Air Act, which is clean healthy air for all Americans. Unfortunately, in 1990 when the law was debated in the Congress, there was a decision made and a vote taken that California would be held to portions of the old Clean Air Act, and it is under that part of the law that the environmentalists have sued EPA, saying California did not develop an implementation plan under the original Clean Air Act.

California has now come forward and developed a plan under the new Clean Air Act. But because of that existing—that retention of the existing law, the old law, we were forced by a series of Federal judges—this was appealed and we lost—to develop a plan in California's stead.

I recently had the opportunity, when we resolved a 30-year issue with the State of California over the San Francisco Bay Delta and the allocation of water resources, to meet with your governor; and I suggested at that time that we would like nothing better on February 14th, when we must appear again in Federal court to join with the State of California, to join with the Wilson administration in saying to the judge, don't force us to implement this, it is not a wise use of taxpayers' resources. Rather, direct us to work—Federal Government, State government and local government—to secure a strong plan, to build on what California has put forward in the FIP and to implement that plan.

That is what we desperately want. We believe that is in the interest of the people of California and we are hopeful that the State of California will join us on February 14th before the judges in this matter to ask for that decision.

Mr. BAKER. You assume that the judge will make a reasonable decision if both of you appear hand-in-hand.

Let me repeat my question. Can you not approve provisionally the plans that they have submitted, reminding you that the 1990 Clean Air Act, as advertised by you, is portraying increasing flexibility to the State; and secondly, is it practical for anyone to have to live under the FIP?

Ms. BROWNER. The FIP was proposed—we conducted hundreds of hours of public hearings, dialogue with affected parties, in California. What we will finally submit to the court, because we are required to do so, will be different than what was originally proposed. We have listened to the City of Los Angeles, we have listened to the businesses of California. In many ways there will be similarities between what we file in Federal court and what the State has proposed.

We are working to review the State's FIP, to review the plan that they have submitted. I do not think, however—we received it shortly before Christmas—that we can be done by February 14th.

We do appreciate the fact that the State has worked to get the plan in to us and are committed to working together to find and finalize and accept a plan that meets the needs of California and complies with the Clean Air Act. We believe that can be done.

The CHAIRMAN. The time of the gentleman has expired.

The gentleman from Pennsylvania.

Mr. MCHALE. Thank you, Mr. Chairman. I would like to offer a bipartisan accolade. I greatly appreciate both the substance and the efficiency of this hearing and would like to compliment our Chairman in organizing it.

My questions are for Ms. Browner, and they specifically relate to urban land reclamation, and specifically brown fields redevelopment, a topic that is very important to my congressional district. I represent the Lehigh Valley of Pennsylvania, a heavily industrialized district, where for the past 100 years we have been producing steel, cement, trucks and other forms of heavy manufacturing.

Many of those industries are experiencing downsizing—dramatically in the case of Bethlehem Steel, which is headquartered in my district. The net result of that is that we have hundreds, perhaps thousands, of acres of older industrial sites that need to be cleaned up and need to be rededicated to viable commercial uses.

We are not talking about Superfund sites; the level of degradation is not that severe. In most cases, the owner of the property is more than willing to cooperate with a prospective purchaser in the cleanup of the site.

My question is, has EPA developed a comprehensive, cost-effective approach to industrial site reclamation? If you have, could you describe that because although I am focusing on an issue of importance to my own district, in fact this problem can be replicated in virtually every congressional district across the country; and if we are going to transition from older, in many cases, less-efficient manufacturing industries to new, commercially viable uses, we have to make sure that that transition in terms of your agency is smooth.

I would appreciate your comments.

Ms. BROWNER. I agree that one of the saddest problems we face in our inner cities is the fenced-off blocks, the areas that cannot be

used for reinvestment, that cannot be used to bring jobs back to the inner city.

We have developed a program, a brown fields project, and have applied it in 10 cities to help the people interested in cleaning up and redeveloping those sites do just that. We are looking at expanding the program based on the successes that we have had. Unfortunately, the single most important thing that we could do to simulate the cleanup and redevelopment of those sites would be to provide legal protection to the lenders, from liability.

EPA proposed and adopted a rule to do just that. We were sued and we lost in court. The court told us we had no authority within the existing law to protect banks, who had no interest in the property previously, so it has become very difficult for investors to find the resources.

Last year—

Mr. MCHALE. If we could explore that for a moment.

What is happening here is you have an owner of a property prepared to sell, eager to clean up the site, and a buyer anxious to purchase for a commercially viable purpose. You have a lending institution that would like to make the mortgage money available but is unwilling to do so in light of the remote possibility that without any culpability on the part of that lending institution, it might ultimately foreclose on the mortgage and find itself liable for any contamination on the site.

Certainly, when the lending institution is guilty of wrongdoing, they should be held accountable, but now we have a legal system that is clogging the marketplace and potentially imposing liability on those who are not at fault; is that an accurate description?

Ms. BROWNER. Absolutely. What is happening is that banks will not make investments in property, they will not lend to people interested in redeveloping property because of the potential for liability. This is one of many unintended consequences, but nevertheless very damaging consequences of the current Superfund law. Even though these are not Superfund sites, they are affected by the very large net that has been cast by the Superfund program.

Last year we worked in a bipartisan manner with Members of Congress to craft a Superfund legislative proposal that enjoyed the support of the American bankers, the Sierra Club, the chemical manufacturers—never before has an environmental piece of legislation had that breadth of support—and we would like to work in this Congress to expeditiously correct the very problems you raise.

Mr. MCHALE. That is my top economic priority. I would encourage you to follow a parallel course.

I compliment you in terms of Superfund reforms, but do bear in mind that in most of our districts brown field redevelopment fortunately is a much more common problem where we have some relatively minor level of degradation; and with a reform of the law, we can take that land, clean it up and put it to commercially viable purposes.

I thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

Mr. Hayes.

Mr. HAYES. I am going to recommend a book Mr. Roemer forgot to mention, I am going to recommend Don Imus's book, God's Other

Son, because it will put you in the right frame of mind for the 104th Congress. Secondly, since Mr. Imus does not know any multisyllable words, it is very easy reading.

Regarding today's topic of science policy, preparing us for the future, I would like to use this occasion to ask Speaker Gingrich if I could please have my telephone communications back, which apparently disappeared from our office on the 1st of January; and secondly, to tell the Speaker that there are some Members of Congress who do not consider the front steps to the Capitol a perk, and possibly we could allow those to be retained at a later time after appropriate hearings have been held.

I am not going to ask any questions of Ron Brown because he has been mad at me since I made a donation to the Smithsonian. You may find it odd that a Cabinet member would be mad that I made a donation to the Smithsonian, and that is simply because what I donated belonged to him.

So my only time-consuming moments will be asking a question of Carol Browner, and first, making an observation prior to that.

The gentleman, I think, was correct and Ms. Browner was correct in talking about the legal system, but I think it wasn't phrased correctly. The legal system is not at any point creating the problem. The legal system is enforcing a law that is the problem. The legal system is simply making determinations that we have statutory and regulatory schemes that are not sensible. For that reason, I don't think it is fair to blame judges for inheriting a system which encourages litigation, which makes it totally and completely remuneratively valuable to encourage litigation which runs up law fees for winners and losers in those environmental suits and that, for that reason, both clogs the system and leads to incredibly idiotic results such as financial institutions that are guiltless, bearing the financial burden of a foreclosure in an economy that could certainly use a boost from government and not a continuing drag or anchor.

The only questions I have deal with risk assessment. Earlier, you said that you agreed with some policies, and I appreciate the Clinton administration elaborating on that, but you added to that there are some points with which you disagree. Not for purposes of confrontation, but for purposes of working with Mr. Walker, which I intend to do in trying to craft a bill that can be embraced by a mainstream that both parties in a nonpartisan manner, tell me the areas of disagreement where you can, so I can see where our policy might clash, in order to try to work toward bridges in the middle.

Ms. BROWNER. Briefly—we could elaborate on these—we see, I think, four primary areas of concern with the language in the Contract With America. The first is, we are concerned that it would—perhaps inadvertently, but nevertheless—freeze science in time. Risk assessment is a relatively young science. It needs to grow and be able to change, so we are concerned about anything that would freeze it in time and not allow us to make the best use of the growth in that particular area of science.

Secondly, and this goes in part to the point you just made, the judicial review components of the contract, we accept and agree with judicial review of ultimate agency decisions. We do not, however, think it is appropriate to clog the courts with review of very complicated scientific analysis.

The third concern we have relates to what we believe would be opportunities for inappropriate delay in action. I will give you a very specific example here. Under the TSCA law, under the toxic substances law, EPA moves very expeditiously, literally within a 90-day period to make a decision about new chemicals. Then they are out of the new chemical program and in the existing chemical program.

Given the kind of review that would be required, as we understand the contract, we would not be able to make that decision in 90 days. First of all, we don't think that is good for the people of this country; secondly, any member of the peer review panel has the right to restart the entire system.

Now, peer review is something I absolutely support. I have moved EPA to the forefront of peer review in government. But to allow one member of a panel, whose responsibility it is to look at the underlying premises of the analysis, to say, we don't agree, and start the loop over again is to ensure that decisions will never be made.

An example would be a safer pesticide coming onto the market, something we would all like. When we put together peer review panels, we may look to people who have had relationships with other companies. They are the best scientists, so we look to them to help us. It might be in their interest to start the loop over to benefit one of their prior, and perhaps future, clients.

One last thing about the provision in the Contract With America. We have spent a lot of time thinking about how to craft risk legislation and would like to work with the Congress. We are obviously concerned about some of the provisions. I will give you one concrete example. We do not think under the risk assessment provisions in the Contract that we could have banned lead in gasoline, and that would have been a horrible mistake for this country; that would have meant that children would permanently suffer learning disabilities.

Mr. HAYES. Mr. Chairman, as you well know, there are people on this side of the aisle who have also served throughout their previous career in the Minority, and we appreciate the way the committee is being handled and look forward to working with you legislatively.

The CHAIRMAN. Thank you.

Time is basically up. I am gratified by the response of the Members. We haven't gotten to all the Members yet. If I can beg the indulgence of the panel to stick with us through two or three other people who are in the room who haven't had a chance to ask questions, I would appreciate it.

I will go next to Mrs. Seastrand of California.

Mrs. SEASTRAND. Thank you, Mr. Chair. And to our witnesses today, I appreciate your input. As a freshman, I am eager to learn and also to work with each and every one of you. I represent the central coast of California. We have Vandenburg Air Force base and our newly created Space Port Authority.

As a recent member of the California State Assembly, it was my legislation to create the California Space Port Authority. Much work is needed to be done to move our commercial space port and I would like to address my question to Secretary Brown. I am very

concerned because in this area we have lost much of our business to France, China, and Russia is very interested in looking to the commercialization of space.

And so my question is very generic, I guess. How do you think—how successful will commercial space ports be in the 21st Century, and what needs to be done to facilitate their success, and how can the Office of Space and Commerce help achieve this goal and to definitely help our entrepreneurs in this new industry?

Secretary BROWN. First, I would respond by saying that these space ports have already demonstrated their success to date by leveraging public funds with private sector and State investment to effectively convert excess government property into valuable dual use assets, or in some cases to build infrastructure where none existed before. And I would expect that with the development of large communication satellite constellations at lower cost, smaller launch vehicles and United States seaports—space ports rather—will continue their contribution to improving the United States space infrastructure into the 21st Century.

As you know, we have spent a good deal of time focusing on our Office of Space and Commerce. I know it is an area your Chairman is very much involved in and concerned about and committed to. We share that commitment. We look to commercialization of space as a very important vehicle for economic growth and job creation in the future and we are anxious to work with you and other Members of the committee in that effort.

Mrs. SEASTRAND. That concludes your questions?

Mrs. SEASTRAND. Yes.

The CHAIRMAN. I thank the gentlelady.

The gentleman from Massachusetts, Mr. Olver.

Mr. OLVER. Mr. Chairman, since I have missed a good portion of this, I would like to listen, if I may, and would you come back to me at the end?

The CHAIRMAN. We are getting down toward the end. We are pretty much at the end at this point. I have Mr. Largent yet, who has come in the room, and then the Chair intends to ask some questions and release the panel. They have been very, very patient with us.

Mr. OLVER. All right. Then I will ask just a couple or one thing. My apology for having come in late, having had another—having been here earlier and having had another committee hearing at the same time, which I think will happen even now with fewer committees and subcommittees occasionally.

I wanted to ask the members of the panel if they could define—give me some instances, maybe each, particularly of Mr. Goldin for space and Mrs. Browner for EPA and Dr. Lane for the NSF, if they might define for me the places where there is any kind of joint research or research and development activity going on on the part of the agencies with other nations, other of our great trading partners. And, in particular, maybe in the—that is a pretty broad question, because it covers a lot of different countries, but one could come down to the Canada, U.S., Mexico area and, in particular, I guess I am interested in that.

Do we have joint research efforts in your areas that would be of mutual benefit with problems that have to be solved, Ms. Browner,

in the environmental area, covering that territory; and maybe in the other cases where there may not be a specific problem that has to be solved, whether we have basic research leading to things which are in your jurisdictions that are covered in that area or others that may—I am sort of interested in getting a sense of what our joint programs or cooperative programs look like.

Ms. BROWNER. We have at EPA several different efforts that I believe fall within the scope of your question.

First of all, we have signed agreements with more than 25 countries around the world to work together on either particular environmental problems to find solutions to better understand the problem in terms of the science of the problem, in some instances to help their environmental agency grow to assume better responsibility to look for new technologies.

In the second area that I think is particularly important, is in the environmental technology arena and the work that we are able to do to help countries understand what a problem is and then find the appropriate American business with the new technology to solve that problem. And we have had some real successes in our work with Mexico, particularly as a result of the NAFTA environmental side agreement, in terms of looking at our problems together and crafting solutions.

It is interesting that in, I think, far too many instances our own environmental laws will not allow some of the technologies that we are advancing in other countries to be used here and it is one of the things that we think has to change. It only makes sense and it is one of the things that we are committed to changing.

The other area we are excited about, the work that we are doing in our basic research, is our effort to reach out, more so in the United States than around the world, but to find the best and the brightest. And I will give you an example of something that happened recently.

We made available on the Internet the possibility for graduate students, this country's future scientists, to apply for grants. Not of a large amount, of a relatively modest amount. We did this about 10 days ago. We thought we might get a couple hundred solicitations. We have received—just on the Internet; we have not mailed anything to anybody—over a thousand applications.

That is the kind of demand there is for seed money for this country's brightest people to be doing basic research. That is what this was for, basic research.

Mr. GIBBONS. I would like to take a shot at this question also. The area that we probably have the largest interaction is in the environmental monitoring field. This is an area that is crucial to U.S. industry because environmental laws around the world are different, and if we are to be competitive in other countries we have to have a basic understanding of the laws and perhaps seek some solutions through the policy-making chain in the government.

By having the lead, the United States, in the EOS program, we are able to provide an exchange of data so there is a mutual trust country to country that we are not trying to get economic benefit when we go look into these environmental situations. Huge. And we are working with Canada and we are working with a lot of countries in this hemisphere.

The CHAIRMAN. Time of the gentleman has expired. If others of you have responses to the rather general question the gentleman posed, but a very good question, again I know he would appreciate to receive them in writing. The committee would also appreciate your responding in writing to the question posed.

[The information follows:]

Material requested for the record on page 137, line 3181 by Cong. Olver during the January 6, 1995, hearing at which Administrator Goldin testified.

ONGOING COOPERATIVE AND REIMBURSABLE INTERNATIONAL ACTIVITIES

CANADA

Cooperative Projects

BOREAS: NASA and Canadian counterparts are cooperating on a study of the interaction between the boreal forest and the atmosphere -- specifically the exchange of energy, heat, water, carbon dioxide and other trace gases. Observations from the Shuttle, as part of NASA's Space Radar Laboratory (SRL) missions allowed scientists to compare spaceborne data with readings from equipment on the ground and aircraft.

CANOPUS: The Canadian Space Agency will make ground-based observations complementary to the International Solar-Terrestrial Physics program.

Commercial Float Zone Furnace: NASA and the Canadian Space Agency (CSA) are cooperating on the flight on the Shuttle of the Canadian float zone furnace. The facility would further research associated with space-based crystal-growth experiments.

EARTH OBSERVING SYSTEM/MISSION TO PLANET EARTH: See BOREAS, RADARSAT, and MOPITT descriptions.

FUSE: NASA and the Canadian Space Agency are cooperating on the U.S. Lyman Far Ultraviolet Spectroscopic Explorer (FUSE) mission. CSA is providing hardware to the mission, which will provide for the first measurements of faint far ultraviolet sources both throughout our galaxy and at very large extragalactic distances.

IML-2: The Canadian Space Agency has participated in microgravity studies on board the Shuttle, such as the IML-2 mission.

MOPITT: This Canadian investigation on Space Station will measure tropospheric pollution -- specifically the global distribution of carbon monoxide and methane in the troposphere.

OEDIPUS-C: NASA will launch a Canadian sounding rocket investigation of ionospheric plasma.

Power Sources Agreement: Canada is lending NASA four solid polymer fuel cell stacks in return for participation in the U.S. Renewable Energy System Testbed program, which is being run out of the Lewis Research Center.

RADARSAT: NASA, the National Oceanic and Atmospheric Administration (NOAA), and the Canadian Space Agency are cooperating on the September 1995 launch of a Canadian remote sensing mission, Radarsat. This mission will provide earth observations for use in the study of the Earth's land, ocean and ice cover;

monitoring of natural resources and environment; and natural disaster prediction.

Space Station: Canada is providing the Space Station Remote Manipulator System and operating the Mobile Servicing System as part of its contribution to the international Space Station. These robotic systems contribute to the assembly, replacement, and repair of on-orbit infrastructure. NASA is currently planning additional joint cooperation in the fields of life and microgravity sciences.

Reimbursable Projects

Balloon Anisotropy Experiment: NASA is launching a Canadian balloon investigation that will measure cosmic background radiation.

Canadair Agreement: NASA is providing testing of a new aircraft wing for Canadair in the Icing Research Tunnel at the Lewis Research Center.

KC-135 Flights: Canada is flying microgravity experiments on board the NASA KC-135 aircraft based at the Johnson Space Center.

Other

Balloon Launches: NASA is launching balloons from Canada in a study of cosmic ray particles entering the Earth+s atmosphere.

MEXICO

Cooperative Projects

HIGH-ALTITUDE RESEARCH AIRCRAFT: NASA flew a high-altitude research aircraft over Mexico in late 1994. Studies of the resulting data will improve understanding of the state-of-the-art remote sensing methods for geologic mapping, and the formation and evolution of geologic terrains in the Guerrero-Morelos Geological Basin and the Mexican volcanic belt.

SPACE RADAR LABORATORY (SRL): Mexican scientists collaborated with NASA on two Shuttle Space Radar Laboratory missions in 1994. The Shuttle carried two types of radars designed to study vegetation coverage, snow packs, wetland areas, geologic features such as rock types and their distribution, volcanic processes, ocean wave heights and wind speeds. Mexican researchers were involved in making complementary observations from the ground during the mission and in studying mission results with their NASA colleagues.

NASA and Mexican scientists from Mexico City's primary university, UNAM, are collaborating in an effort to map and assess volcanic hazards in the Mexican volcanic belt, especially active volcanoes and associated landslides -- using remote sensing and digital terrain data.

NASA has selected Mexican investigators as part of the SeaWiFS science team for the validation of ocean color data which indicates ocean productivity.

DOSE: The Dynamics of the Solid Earth (DOSE) program is a NASA-led global study of crustal motion and plate tectonics involving over 45 countries worldwide.

This program will apply space geodetic technologies to the understanding of crustal dynamics, including research on earthquakes and other natural hazards. NASA has cooperative programs with the following Latin American and Caribbean countries to conduct long-term measurements of crustal motion as part of the DOSE program: Mexico, Costa Rica, Ecuador, Peru, Chile, Bolivia, Venezuela, Trinidad and Tobago, Dominican Republic, Panama, and Colombia.

INFORMATION PROVIDED FOR THE RECORD

INTERNATIONAL RESEARCH ACTIVITIES OF THE NATIONAL SCIENCE FOUNDATION

The National Science Foundation has a substantial amount of international research activities, including joint efforts with both Mexico and Canada. NSF-supported collaborative research with the two countries is diverse. Research areas of collaboration include the study of earthquakes and global change, astronomy, ecology, and materials science, to name a few.

NSF has had a long-standing collaborative research program with Mexico, involving their National Research Council for Science and Technology. (CONACYT) as a counterpart agency under the current bilateral Science and Technology (S&T) agreement. Although no such formal agreement exists with Canada, NSF supports many activities that involve Canadian scientists and engineers in collaborative research, and maintains close ties with the Canadian Natural Sciences and Engineering Research Council (NSERC) and the Canadian National Research Council.

Last February, in a trilateral meeting of heads of science agencies, the Directors of CONACYT, NSERC, and NSF agreed to review periodically opportunities for collaborative work, particularly in a trilateral context. A direct outcome of this meeting was the creation of the North American Research Fellows Program, designed to support U.S. researchers interested in conducting research in Canada or Mexico. Canada and Mexico each have parallel programs as well. In addition, the review led to the support of a trilateral summer institute that took place in Canada last summer on the issue of industrial competitiveness, with scholars, graduate students and young researchers from the three countries. Other programs include: a new U.S.-Mexico program for collaborative research in computer science; and an initiative in materials science designed to link, through the Internet, research institutions and materials science centers in the three countries.

In November 1994, a Joint Statement of Cooperation among NSF, CONACYT, and Industry Canada affirmed the intention to continue collaborations in National Science & Technology Week activities that include support of national and local public events engaging families, schools, universities, community organizations, scientific societies, and business and industry programs in partnerships to foster public awareness of science and technology on daily life. These partnerships aim particularly to attract underrepresented minorities and women to studies and careers in science and engineering. Through cooperative development of formal and informal educational opportunities--materials, electronic communications, model teaching program exchanges, this North American Alliance for Public Understanding of Science and Technology means to increase public science literacy, citizen participation in issues affecting society,and the capability of the work force of the 21st century.

Several additional international collaborative efforts are of particular note. One is the Gemini 8-Meter Telescopes Project, an international partnership which will construct two 8-meter telescopes, one in the northern hemisphere, to be located in Hawaii, and one in the southern hemisphere, to be located in Chile. The Project is an international collaboration with the United Kingdom, Canada, Chile, Argentina and Brazil. The total budget for the Project is $176.00 million, with the U.S. providing 50% of the funding and the five other countries providing the remainder.

Another international collaborative effort is the Ocean Drilling Program, a multinational program to improve fundamental understanding of the physical, chemical and biological processes that determine the geological history, structure and evolution of the oceanic portion of the earth's crust. Funding for the program, which includes drilling operations, shore laboratories, core repositories and associated data banks, is shared by 6 international partners, comprising 18 countries. The six international partners, in addition to the U.S., are Canada, Germany, France, Japan, the U.K., and the European Science Foundation (which includes a number of countries).

INTERNATIONAL RESEARCH
Question from Congressman Olver
Follow-up to January 6, 1995 hearing before the House Science Committee

Define EPA's joint research and development activities with other nations

As Administrator Browner stated at the January 6, 1995 hearing before the House Science Committee, EPA has signed agreements with over 25 countries to work together on particular environmental problems, or, in some instances, to help their environmental agencies better assume responsibility for the environment. Examples include:

- **Mexico:** Regarding Mexico, we are conducting research on pollutants affecting the US-Mexico border region to gain a better understanding of the health effects of these pollutants and the sources of these pollutants.

- **Israel:** EPA is involved in the Binational Science Foundation (BSF), a bilateral science and technology program between the U.S. and Israel. The BSF was established in 1972 and provides money for projects of benefit to both countries. The funding for these projects does not come from EPA's budget, but from a separate fund specifically set up by the governments for joint research. This Joint Fund is used to support broad scientific and technology cooperation between the U.S. and Israel. The fund was created to promote international cooperation in science and technology, to foster friendship and understanding between the countries, and to utilize progress in science and technology for mutual benefit.

- **Central and Eastern Europe:** EPA is also involved in similar science and technology joint funds with most of the countries of Central and Eastern Europe, specifically Poland, Hungary, the Czech Republic, Slovakia, Croatia and Slovenia.

  These programs provide money for joint research projects of benefit to both countries. The funding comes from a separate fund specifically set up by the U S and these countries for joint research, not from EPA funds. These Joint Funds are used to support broad scientific and technology cooperation between the U.S. and the countries of Central and Eastern Europe. The funds were created to promote international cooperation in science and technology, to foster friendship and understanding between the countries, and to utilize progress in science and technology for mutual benefit. We have scientists conducting joint research with scientists in these countries on issues ranging from contaminated food to reducing heavy metals in wastewater, to risk assessment.

- **Russia:** EPA has had a longstanding research relationship with the former Soviet Union under the US-Russia Joint Committee on Cooperation in the Field of Environmental Protection. Through this relationship, the US collaborated with scientists from the former Soviet Union on such topics as air pollution, ground water modeling and wetlands. More recently, however, we have been collaborating with Russia through the auspices of the Gore-Chernomyrdin Commission.

- **Asia:** Through the U.S. - Asia Environmental Partnership (AEP), EPA has been conducting joint activities with a variety of countries in Asia, including Thailand, where we have been conducting joint air monitoring activities; and Malaysia, where we recently completed a one-week risk assessment seminar. We also have joint research going on with China, looking at the health effects of air pollution from burning coal.

- **World Health Organization:** EPA maintains cooperative agreements with both the International Programme on Chemical Safety and the Division of Environmental Health of the World Health Organization in Geneva, Switzerland. These cooperative agreements provide for a wide range of joint activities, including: harmonization of risk assessment methodology, development of an intergovernmental mechanism for chemical risk assessment and management, development of reports and documents on the health effects of chemical compounds and on scientific methodology for chemical evaluation, and training in a wide variety of areas including exposure assessment. EPA scientists provide considerable support to WHO in the form of peer review for WHO documents. EPA also maintains a cooperative agreement with the Pan American Health Organization (PAHO), a division of WHO. The PAHO cooperative agreement provides for joint activities similar to those with the International Programme on Chemical Safety and the Division of Environmental Health.

Mr. OLVER. Mr. Chairman, may I put a little clarity to the kind of answer that might be helpful, at least to me?

The CHAIRMAN. Briefly.

Mr. OLVER. Yes. For instance, with Ms. Browner—

The CHAIRMAN. I don't want you to—I want you to—

Mr. OLVER. She made very general comments about cooperation and partnership, as many as 25 countries, but I do not know specifically at all what that is. And I would like you to give me a few examples of what may be binational partnership cooperation, multinational, of things that you think are really solving, really going at solving some problems where the impact of American science may be the driving force in this process and it may be that there are other places where it is a totally cooperative sort of a situation.

That is what I am looking for from each of the three members in particular that I asked for. And I am surprised, in the case of Mr. Goldin, that the Space Station did not come up at that point that you chose to talk about.

Thank you, I am sorry.

The CHAIRMAN. The gentleman from Oklahoma, Mr. Largent.

Mr. LARGENT. Thank you, Mr. Chairman.

I want to put everybody at ease and let you know that I want to make a brief statement and do not have any questions. I was reminded yesterday that one of our Presidents, William Henry Harrison, had the longest inauguration speech and the shortest term, so I want to say I have learned from that.

I want to apologize, too, for not having the opportunity to hear all the testimony. I came from another committee hearing. It was the Budget Committee. And I would just tell our distinguished panelists to brace yourself; that we fully intend to see the government do what every other business has had to do for the last three or four years, and that is to right size the Federal Government with compassion.

I want to say just briefly that I am a father with four children, and I can tell you that many times I walk in the front door of the house and I hear the four children squabbling. And as we go in to—my wife and I try to go in and sort out what the problem was and where the fault lies, that in unison my four children say, it wasn't my fault, I didn't do anything. And, invariably, without fail, with few exceptions, all of them were at fault at some level.

And even in my short time at this meeting this afternoon, I have heard it is the judges' fault, it is the lawmakers' fault, it is the agencies' fault. And I would just encourage all of us to say let's get beyond trying to blame whose fault it is and start getting at the heart of the issue and working on how we resolve it and do what I campaigned on, and that is get the Federal Government off the backs of the people and their businesses.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Mr. Largent.

Once again, let me thank the panel for your participation. We have kept you here a long time as we have asked these questions, but I think the questions have been very good and a large portion of them have been very much in the spirit of looking at the future of science.

Let me give you a little perspective of what I had in mind as a part of thinking about this hearing and then maybe get your comment.

It seems to me that what we have to do, if we are going to begin the restructure government in ways that make sense toward 20 years out, we have to get past the idea of thinking of all these things as government programs and we have to begin to think about a society restructured where science is an integral part of addressing that whole panoply of economic interests, but also it goes to the very nature of our culture as well, of being an exploring culture.

And a couple of examples of the type of thing that I would like to have us think about as we move into our new role in working with each other, in the case of EPA, Ms. Browner, I agreed with much of what you said in your statement, about the need for science to deal with those broad issues out there to protect public health and safety. It seems to me, though, we have a choice to make between whether or not we do that through regulation or whether we do it through the development of different kinds of ways of handling the needs of society.

In the area of energy, would we be better off putting the science dollars toward developing an absolutely clean energy that does not require any regulation? Or would we be better off putting the money toward the sciences necessary to create a broader regulatory scheme?

It seems to me if we are looking toward the year 2015, what we want is a clean environment. There may be strategies for getting there that are entirely different than a massive regulatory approach, and investments in science to get us toward that kind of thing would be better.

In the case of NOAA, under your jurisdiction, Secretary Brown, my guess is that one of the great needs of the future, and one of the things we will have an opportunity to do, is do better weather forecasting. And by the year 2015, we are going to have the opportunity to do some significantly better things in weather forecasting, in part based upon better space-based assets. And the whole microminiaturization revolution gives us the opportunity to think in those terms.

Now, it also seems to me, then, at the Department of Commerce, at the area of space and commerce, that one of the things we should look at is the fact that whole constellations of satellites are now going to go in place for communications purposes. But what if some small device could be put aboard those satellites that would allow every piece of the globe to be looked at all the time, with instruments aboard those satellites, and would allow us, therefore, to deal with wind sheer at a localized level immediately? And what does it take in terms of government policy to get those instruments put on a commercial project? Is there a tax incentive that says to them that if you are putting a constellation of satellites in place that you should put one of those devices aboard that constellation so that we have that ability, so that NOAA has the ability to purchase that kind of very good information?

To Dr. Lane, it seems to me what we want to think about is, yes, applied and basic research are both very important parts of our

overall goal as a Nation. I tend to agree with Mr. Ehlers' characterization of it, but it seems to me that what we have to think about is where it is that government's best investment is made. And if government peels too much away doing the applied kinds of research or the directed basic research, then what we lose is the ability to develop the knowledge that may be the basis for something we cannot even think about in the year 2015 at the present time. I am concerned about that.

Mr. Goldin, at NASA, I am concerned about space access and how we get there. And the questions that the gentlelady from Texas asked a while ago are exactly the right questions. How do we afford to do that? Maybe we cannot afford to do it all in NASA. Maybe it can only be afforded to be done because we create the private sector incentives that allow that kind of rocket to be built. Maybe all the things NASA has to go through create too much baggage for a launch vehicle, and maybe we need to have a launch vehicle that takes far more risks than NASA could ever do under the aegis of Congress.

You know, Mr. Gibbons' coordinating all that becomes a real challenge. But I think what I would like to see is this committee working with all of you so that all of those kinds of things come together in a strategy that involves not just the programs this committee authorizes. That is a small part of all of this. But so that we can work with places like Ways and Means and decide where the tax incentives have to be for all of this; so that we can work with the Committee of Commerce and decide where some of the things that we are doing now can be modified to better inspire somebody to do the science.

One of the most exciting things I heard here, Ms. Browner, is when you suggested that all these young people are out there just waiting to participate and saying all you have to do is put it on the Internet. We should put a lot more stuff on the Internet to get their participation, and I am hopeful this committee will encourage that.

I would appreciate any comments about what I just talked about.

Secretary BROWN. Mr. Chairman, just a brief comment. The kind of thinking that you are suggesting is the kind of thinking we are doing, and, more importantly, the kind of action we are taking. The clean car initiative is one example of that, to look at a different approach. How do we get a vehicle that does not pollute and, therefore, the regulatory process would be one we would not have to undertake should we reach that goal. How do we incentivize the private sector?

So I think in many respects, Mr. Chairman, we are on the same wavelength and that is why we look very much forward to working with you as Chairman and with the rest of the Members of your committee to reach those goals for 2015 and beyond.

The CHAIRMAN. Just for a little bit of dialogue here. The thing that concerns me a little bit about the clean car approach, though, is that it seems to me you also have to start with the idea that maybe there is a clean fuel before that. Because if what you do is take the clean car approach, and they assume the infrastructure in place is the infrastructure we are going to have 20 years out, that does not make much sense. However, you if you assume there will be an entirely different infrastructure, for instance, supporting a

hydrogen based fuel, it becomes a much different kind of clean car that you develop.

One of the concerns that I am—and we are going to talk a lot about, ATP and so on—but one of the concerns I have about some of those kinds of programs is they tend to fund people who are somewhat status quo oriented, who are protecting their own bastions. And clean car initiatives and so on, being done with the automotive industry, the automotive industry has huge investments in what they are now doing. So every time you have them get involved in these things, they do tend to like to protect at least some of the status quo.

Secretary BROWN. But that is exactly why they have to be incentivized to do something different, because unless there is a government-private sector partnership, they will not do anything different. Unless we do things policy wise, Mr. Chairman, to push them and cajole them and encourage them to do things differently, we will not make the kind of progress we can make by—

The CHAIRMAN. The question becomes always what those incentives are. For example, my guess is you will get far more in the way of space assets flown, to go to another system, some more commercial space, if you told people that you can have tax free profits with any product made in outer space for 10 years.

There is no program I can create here at this level or no amount of money I can force into the system that is at all rational, that will do more to inspire somebody to begin thinking about those things than to tell them that if you figure out some way to get there and do it profitably, we will allow you tax free profits for 10 years.

Secretary BROWN. Well, I want to work with you, Mr. Chairman, and work on you on the ATP program. I think Congresswoman Morella and others will join me in that effort. I don't agree fully with your assessment of the program and I would like to prove my point.

The CHAIRMAN. Well, that is the dialogue we are going to have. Ms. Browner.

Ms. BROWNER. Mr. Chairman, I would like to agree with what I think I heard you say, which is quite simply, aren't we better off preventing pollution in the first instance rather than to seek to minimize it, cleaning up, putting in place an end of the pipe command and control regulatory system.

Since coming to my job at EPA, I have called for a new generation of environmental protection, one that goes beyond pollutant by pollutant, one size fits all, regulatory system. There is a lot of good that has come from that system, but it is not adequate to meet the challenges of the future. It is not adequate to find the answers that none of us can today predict may be available in 5 or 10 years. So anything we can do to create incentives, and it was interesting to hear you talk about tax incentives that will allow businesses to make the kind of pollution prevention investments that many of them want to do today, is extremely exciting to us.

You know, if you had asked me what I thought would be the role of the Environmental Protection Agency more broadly in the year 2015, I would tell you it would be to work in partnership with the industries, with the people of this country to make sure that we

have found the very best, the most cost-effective common sense solutions, and that we have moved beyond the mere regulatory tool as the best way of achieving those outcomes. So we are very excited about your—

The CHAIRMAN. That is the reason why I hope when you communicate with the Committee on Science, whether you are coming up here to testify or you are communicating to us through your—through letters or however we are talking, that you will think about science in a broad context. And if there is something that is not necessarily our jurisdiction but needs to be done, please communicate that to me as the Chairman of Science. Because one of the things that we are trying to do to restructure the House is, if it is a tax incentive, I am going to sit down and talk to Bill Archer. And we are going see whether there is a way Ways and Means and Science can work together to do these things together. We are going to try to get ourselves outside the bounds of the four walls that surround these committees; that the only thing that ever goes on in science goes on in a committee called Science. I just don't think that works in the modern context.

Mr. Goldin.

Mr. GOLDIN. Mr. Chairman, I would like to say in that same spirit, if we look to the year 2015, I would like to see the contractors not look upon NASA as the customer where they will do work and then earn a profit. I would like the contractors to look upon NASA as a place they can come to work cooperatively to get technology and get leading edge. And the only way that can happen is the way you are suggesting, and that is really work the policy issues.

There are a number of things that will help us minimize the amount of government money expended but maximize the impact on the overall American society. And I think that is a very fruitful field to plow.

The CHAIRMAN. Dr. Lane.

Mr. LANE. Mr. Chairman, what motivates scientists really is curiosity, it is mystery, but it is also the chance of discovery. Scientists need to be free to explore and to make those discoveries, so we have to keep them out of boxes, and certainly you have my commitment to do that.

But many scientists are also motivated by the thought that what they do might ultimately be valuable to people, to the public at large. Many scientists like to know that the chemistry they are doing, the atmospheric science, the oceanography might help us understand the global environment. Or many computer scientists are excited about the idea that the information superhighway may arrive faster and better with their efforts. So we want to make sure we do not have barriers there that prevent the most outstanding scientists from being motivated in those ways.

In any case, we are going to focus on the best people, on the best ideas, and on our nurturing those scientists for the future, and we look forward to working with the committee.

The CHAIRMAN. Thank you, Dr. Lane.

And, Dr. Gibbons, I let you sum up at the beginning, and I will let you kind of sum up and finish up here at the end, if you would, please.

Mr. GIBBONS. Mr. Chairman, there is an old Chinese statement that says the more you say the less people will remember, and I think we have had a very rich dialogue today. It is an excellent start. I applaud the idea of a periodic regathering in working with this committee.

We are here in the administration as agents of change and we—I sense personally a strong reinforcement of that notion this morning and I think together we can make a lot of ground in the coming year. Thank you very much.

The CHAIRMAN. Thank you, Dr. Gibbons.

Again, thank you to all the members of the panel. You have been most patient with us today, I appreciate that, and we look forward to working with you in the future.

The hearing is adjourned.

[Whereupon, at 12:55 p.m., the committee was adjourned.]

APPENDIX

Responses to written questions submitted by Cong. Walker resulting from the January 6, 1995, hearing at which Administrator Goldin testified.

QUESTION 1:

Radioisotope Thermoelectric Generators (RTGs) use plutonium to produce energy for missions that are traveling to the outer planets. Solar power becomes increasingly less effective the further one moves away from the Sun.

What will NASA's long-term requirements be both for the short-term and the long-term?

ANSWER 1:

Requirements for Radioisotope Thermoelectric Generators (RTGs) for the Cassini program (3 RTGs and 157 Radioisotope Heating Units or RHUs) are addressed in the Fiscal Year 1996 budget request, consistent with the July 1991 DOE/NASA Memorandum of Understanding [MOU] between DOE and NASA Concerning Radioisotope Power Systems for Space Missions. Supplement No. 1 to that MOU delineates the specific responsibilities of the Department of Energy (DOE) and NASA relative to the provision of the RTGs and RHUs for the Cassini spacecraft.

NASA's space science mission model, and the corresponding future requirements for space nuclear power, are under review given NASA's plans to employ smaller spacecraft, where possible, to accomplish future space science missions. These plans apply both to outer planet missions and solar probe missions -- missions that tend to require RTGs, or other means of generating power.

Preliminary results indicate a continued requirement to maintain the infrastructure to support the use of space nuclear power. Additionally, it is anticipated that advanced development in space nuclear power will be required to support the move to smaller spacecraft. NASA and DOE are now in the process of identifying the proposed funding arrangements to support these future activities, and we anticipate that these discussions will be concluded in time to be reflected in the President's fiscal year 1997 budget request.

QUESTION 2:

What is the Administration's position on RTGs?

ANSWER 2:

In general, NASA uses RTGs where they are the only feasible means of providing electrical power to a spacecraft, as with deep space missions where solar intensity is so low that with current solar/electric conversion technology, a spacecraft would require extremely large, heavy, complex solar panels. This alone makes the use of solar panels for such missions impractical. RTGs remain unmatched by any other power source for missions to the outer solar system or in regions of intense radiation, such as in close proximity to our Sun.

The Administration's position on RTGs and safety is that: where they make sense, based on the scientific and technical requirements of the particular mission,

radioisotope power sources (RTGs and/or RHUs) will be used. In all cases, RTGs will be designed to ensure that our missions are conducted consistent with interagency approval and with maximum attention to safety considerations.

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20500

February 6, 1995

The Honorable Robert S. Walker
Chairman
Committee on Science
U.S. House of Representatives
Washington, D.C. 20515

Dear Congressman Walker:

In response to your letter of January 17, 1995, I am submitting a reply to your follow-up question to the hearing of January 6 for inclusion in the printed record.

Sincerely,

John H. Gibbons
Director

Enclosure

ADDITIONAL QUESTION TO HEARING OF JANUARY 6, 1995

1. Is the science of ozone depletion and climate change good enough to merit continued U.S investments in the research and U.S. participation in international treaties?

Unequivocally yes. Ozone depletion and climate change are serious environmental issues of vital importance to the American public. These issues are no longer the sole concern of the academic community and environmentalists: governments of all persuasions and industry around the world have also recognized their importance.

While there is no doubt that human activities have significantly reduced stratospheric ozone and increased the global concentrations of key greenhouse gases, the observed climate change of the last 100 years cannot yet be unequivocally attributed to human emissions of greenhouse gases.

Informed national and international policy formulation requires an improved understanding of the natural Earth system and how human activities are influencing it. The U.S. Global Change Research Program (USGCRP) is scientifically and technically credible and provides national and international decision-makers in governments and the private sector with expert, unbiased, peer-reviewed information for policy formulation. Consequently, it essential that the USGCRP continues to be funded. Representatives of industry, academia, government laboratories, Congress, State and local government are involved in setting the priorities of the USGCRP, which is a comprehensive program of process studies, theoretical studies, field measurements (ground-based, aircraft, balloon and satellite), and assessments. The USGCRP contributes to international programs such as the World Climate Research Program and the International Geosphere Biosphere Program, thus leveraging the research dollars of other countries.

The issues of ozone depletion and climate change are both global issues. Actions to limit the emissions of ozone depleting substances or greenhouse gases by the U.S., or even OECD countries, alone would not be adequate to address these issues. Actions must be global. Therefore, U.S. participation in the international Treaty processes is essential.

One vital element in ensuring that policymakers are armed with the latest scientific and technical information relevant for the international treaties is the World Meteorological Organization (WMO) and United Nations Environment Program (UNEP) assessment process for climate (Intergovernmental Panel on Climate Change) and ozone. In the opinion of the Clinton Administration, these assessments are the best mechanism for obtaining a credible and unbiased review by experts from academia, government, industry and environmental organizations of the state of knowledge for informed policy formulation. These assessments are based on the latest scientific research, in particular the research findings of the USGCRP.

The following two sections summarize the latest scientific understanding of some of the key points.

Ozone Depletion:

The issue of stratospheric ozone depletion is of critical importance to the health of Americans Any significant decrease in stratospheric ozone would lead to an increase in the levels of ultraviolet radiation (UV-B) reaching the Earth's surface with adverse consequences for human health, in particular an increase in the incidence non-melanoma skin cancer, melanoma skin cancer, eye cataracts, and a possible suppression of the immune-response system.

1. There is no doubt that the major source of atmospheric chlorine and bromine is from human activities (e.g., CFCs and Halons), not from natural sources such as volcanoes or sea spray.

2. There is no doubt that downward trends of ozone are occurring at all latitudes, except the tropics, during all seasons. Extensive ground-based data and satellite data have shown that since 1970 ozone has decreased by about 5-6% in summer and 9-11% in winter/spring in northern mid-latitudes, and by 8-9% at southern mid-latitudes on a year-round basis.

3 There is no doubt that the spring-time Antarctic ozone hole is due to anthropogenic chlorine and bromine---based on combining ground, aircraft, balloon and satellite data, with laboratory data and theoretical modeling.

4. The weight of scientific evidence strongly suggests that the observed mid-latitude downward trends of ozone are due in large part to anthropogenic chlorine and bromine.

5. During periods of low ozone, stations in Antarctica, Australia and mountainous regions in Europe, have shown that as ozone levels decrease ground-level UV-B increases as expected.

6. The rate of increase of atmospheric chlorine and bromine has slowed considerably in recent years demonstrating the effectiveness of the Montreal Protocol and its amendments Even so, the mid-latitude ozone loss and the hole over Antarctica are not expected to disappear until the middle of the next century.

Global warming

Changes in climate (temperature, precipitation, soil moisture and sea level) and climate variability (floods, droughts and severe storms) can affect terrestrial and aquatic ecological systems, human health, and socio-economic sectors (including, agriculture, forestry, fisheries, water, and human settlements).

1. There is no doubt that the atmospheric concentrations of greenhouse gases have increased substantially since the pre-industrial era due to human activities, particularly carbon dioxide (30%), methane (more than a factor of 2), nitrous oxide (15%), and the chlorofluorocarbons.

2. There is no doubt that increases in greenhouse gas concentrations will affect the radiation balance of the Earth's atmosphere. Part of this affect will be offset by increases in sulfate and carbonaceous aerosols (highly regional) and by stratospheric ozone depletion.

3. The major uncertainties associated with quantifying the climatic response to an increase in radiative forcing are associated with understanding the response of clouds, tropospheric water vapor and the oceans.

4. Based on General Circulation Models (GCMs), there is a general consensus that doubling the atmospheric concentration of carbon dioxide (CO_2) would lead to an increase in the Earth's temperature of 2.7 to 8.1°F (1.5 to 4.5°C) at equilibrium. The predicted change in global mean temperature to a doubling of CO_2 is commonly known as the climate sensitivity.

5. Based on the most plausible projections of greenhouse gas emissions and climate sensitivity the Earth's climate is predicted to warm by between 2 and 7°F by 2100, which is considerably larger than the natural variation.

6. Predictions of regional climate change, changes in climate variability, and changes in the frequency and intensity of extreme events are significantly more uncertain than predictions of the changes in the global mean.

7. Changes in U.S. temperatures are projected to be greater than the global mean, and soil moisture is projected to decrease over parts of the U.S.

8. The Earth's climate has warmed by between 0.5 and 1.1°F over the last 100 years, with the nine warmest years occurring since 1980. This increase cannot be directly attributed to global warming, but is consistent with the model simulations if the effect of aerosols (sulfate and carbonaceous) are taken into account.

9. 1994 was the third/fourth warmest year on record, suggesting the atmosphere has rebounded from the transient cooling of 0.9°F caused by Mt Pinatubo and simulated by the GCMs.

10. Carbon cycle models suggest that limiting atmospheric CO_2 to any level between one and two times today's concentrations (350-750 ppmv) would require global emissions to eventually drop below current levels.

Conclusion.

National and international policies must be formulated in light of acknowledged uncertainties. Decisions taken now will have long-term consequences because the climate system is composed of a number of interacting components that have time scales ranging from decades to millennia: (i) stabilization of atmospheric concentrations of CO_2 takes centuries after stabilization of emissions; (ii) equilibration of the climate system takes decades after stabilization of greenhouse gas concentrations; (iii) sea level takes centuries to equilibrate with a new equilibrium climate; (iv) restoration of damaged ecological systems takes decades to centuries, and species extinction can never be reversed; and (v) without premature retirement, turnover of the capital stock responsible for emissions of greenhouse gases (e.g., power plants) takes many decades. Consequently, if policymakers wait until there is an observable change in climate that can be ascribed unambiguously to human emissions of greenhouse gases, and the consequences of that change are deemed to be undesirable, even with a complete cessation (which is not practical) of greenhouse gas emissions the climate system will not recover for several centuries. Therefore, scientific uncertainty should not mean that the U.S. cannot position itself better to cope with the broad range of impacts possible under climate change or protect itself against potentially costly future outcomes. Delaying anticipatory measures may leave the U.S. poorly prepared to deal with the changes that do occur and may increase the possibility of impacts that are irreversible or otherwise very costly. Options that are justified for other reasons today and at the same time make us more flexible or resilient to the changes posed by the threat of climate change are particularly desirable.

The Clinton Administration is strongly committed to addressing the challenge of climate change, with cost-effective policies that are good for the environment and the economy, and make us more resilient. We support policies that provide insurance to reduce risks posed by climate change. Our approach has three pillars. First, our policies are based on sound science. We strongly believe that policies should be based on partnerships with the private sector--industry and non governmental organizations alike. This issue must be addressed in close cooperation with all stakeholders. And finally, we believe that climate change requires international solutions. Climate change is a global problem, and must be addressed by the global community.

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